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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	10271-007-999	*Total Pages*	
First Named Inventor or Application Identifier			
James F. Young			
Express Mail Label No.	EL 501 636 154 US		

JC784 U.S. PTO 09/724290 11/28/00

JC672 U.S. PTO 11/28/00

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

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Washington, DC 20231

1. ☒ Fee Transmittal Form
   Submit an original, and a duplicate for fee processing)
2. ☒ Specification [*Total Pages* 149]
   (preferred arrangement set forth below)
   - -Descriptive title of the Invention
   - -Cross Reference to Related Applications
   - -Statement Regarding Fed sponsored R&D
   - -Reference to Microfiche Appendix
   - -Background of the Invention
   - -Brief Summary of the Invention
   - -Brief Description of the Drawings *(if filed)*
   - -Detailed Description of the Invention (including drawings, *if filed*)
   - -Claim(s)
   - -Abstract of the Disclosure
3. ☒ Drawing(s) *(35 USC 113)* [*Total Sheets* 2]
4. ☒ Oath or Declaration (unexecuted) [*Total Sheets* 2]
   a. ☐ Newly executed (original or copy)
   b. ☐ Copy from a prior application (37 CFR 1.63(d))
   (for continuation/divisional with Box 17 completed)
   [Note Box 5 below]
   i. ☐ DELETION OF INVENTORS(S)
   Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33 (b).
5. ☐ Incorporation By Reference *(useable if Box 4b is checked)*
   The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. ☐ Microfiche Computer Program *(Appendix)*
7. ☐ Nucleotide and/or Amino Acid Sequence Submission
   (if applicable, all necessary)
   a. ☐ Computer Readable Copy
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ACCOMPANYING APPLICATION PARTS

8. ☐ Assignment Papers (cover sheet & document(s))
9. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney
   (when there is an assignee)
10. ☐ English Translation Document *(if applicable)*
11. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
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17. **If a CONTINUING APPLICATION,** *check appropriate box and supply the requisite information:*
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ATTORNEY DOCKET NO. 10271-007-999

Date: November 28, 2000

Assistant Commissioner for Patents
Box PATENT APPLICATION
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Sir:

The following utility patent application is enclosed for filing:

Applicant(s): James F. YOUNG, Scott KOENIG and Leslie S. JOHNSON

Executed on: Unexecuted

Title of Invention: **METHODS OF ADMINISTERING/DOSING ANTI-RSV ANTIBODIES FOR PROPHYLAXIS AND TREATMENT**

PATENT APPLICATION FEE VALUE

TYPE	NO. FILED	LESS	EXTRA	EXTRA RATE	FEE
Total Claims	312	-20	292	$18.00 each	$ 5,256.00
Independent	23	-3	20	$80.00 each	$ 1,600.00
				Minimum Fee	$ 710.00
				Multiple Dependency Fee If Applicable ($270.00)	$ 270.00
				Total	$ 7,836.00
				50% Reduction for Independent Inventor, Nonprofit Organization or Small Business Concern (a verified statement as to the applicant's status is attached)	- $ 0.00
				Total Filing Fee	$ 7,836.00

- ☐ Priority of application no. filed on in is claimed under 35 U.S.C. § 119.
- ☐ The certified copy of the priority application has been filed in application no. filed
- ☐ Amend the specification by inserting before the first line the following sentence: This is a continuation-in-part of application no. filed .

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Respectfully submitted,

Anthony M. Insogna 35,203

Anthony M. Insogna (Reg. No.)
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Reg No. 40,922

Enclosure

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METHODS OF ADMINISTERING/DOSING ANTI-RSV ANTIBODIES FOR PROPHYLAXIS AND TREATMENT

1. INTRODUCTION

The present invention relates to compositions comprising antibodies or fragments thereof that immunospecifically bind to a RSV antigen and methods for preventing, treating or ameliorating symptoms associated with respiratory syncytial virus (RSV) infection utilizing said compositions. In particular, the present invention relates to methods for preventing, treating or ameliorating symptoms associated with RSV infection, said methods comprising administering to a human subject an effective amount of one or more antibodies or fragments thereof that immunospecifically bind to a RSV antigen, wherein a certain serum titer of said antibodies or antibody fragments is achieved in said human subject. The present invention also relates to detectable or diagnostic compositions comprising antibodies or fragments thereof that immunospecifically bind to a RSV antigen and methods for detecting or diagnosing RSV infection utilizing said compositions.

2. BACKGROUND OF THE INVENTION

Respiratory syncytial virus (RSV) is the leading cause of serious lower respiratory tract disease in infants and children (Feigen et al., eds., 1987, *In: Textbook of Pediatric Infectious Diseases*, WB Saunders, Philadelphia at pages 1653-1675; New Vaccine Development, Establishing Priorities, Vol. 1, 1985, National Academy Press, Washington DC at pages 397-409; and Ruuskanen et al., 1993, Curr. Probl. Pediatr. 23:50-79). The yearly epidemic nature of RSV infection is evident worldwide, but the incidence and severity of RSV disease in a given season vary by region (Hall, C.B., 1993, Contemp. Pediatr. 10:92-110). In temperate regions of the northern hemisphere, it usually begins in late fall and ends in late spring. Primary RSV infection occurs most often in children from 6 weeks to 2 years of age and uncommonly in the first 4 weeks of life during nosocomial epidemics (Hall et al., 1979, New Engl. J. Med. 300:393-396). Children at increased risk from RSV infection include preterm infants (Hall et al., 1979, New Engl. J. Med. 300:393-396) and children with bronchopulmonary dysplasia (Groothuis et al., 1988, Pediatrics 82:199-203), congenital heart disease (MacDonald et al., New Engl. J. Med. 307:397-400), congenital or acquired immunodeficiency (Ogra et al., 1988, Pediatr. Infect. Dis. J. 7:246-249; and Pohl et al., 1992, J. Infect. Dis. 165:166-169), and cystic fibrosis (Abman et al., 1988, J. Pediatr. 113:826-830). The fatality rate in infants with heart or lung disease who are hospitalized with RSV infection is 3%-4% (Navas et al., 1992, J. Pediatr. 121:348-354).

RSV infects adults as well as infants and children. In healthy adults, RSV causes predominantly upper respiratory tract disease. It has recently become evident that some adults, especially the elderly, have symptomatic RSV infections more frequently than had been previously reported (Evans, A.S., eds., 1989, Viral Infections of Humans. Epidemiology and Control, 3rd ed., Plenum Medical Book, New York at pages 525-544). Several epidemics also have been reported among nursing home patients and institutionalized young adults (Falsey, A.R., 1991, Infect. Control Hosp. Epidemiol. 12:602-608; and Garvie et al., 1980, Br. Med. J. 281:1253-1254). Finally, RSV may cause serious disease in immunosuppressed persons, particularly bone marrow transplant patients (Hertz et al., 1989, Medicine 68:269-281).

Treatment options for established RSV disease are limited. Severe RSV disease of the lower respiratory tract often requires considerable supportive care, including administration of humidified oxygen and respiratory assistance (Fields et al., eds, 1990, Fields Virology, 2nd ed., Vol. 1, Raven Press, New York at pages 1045-1072). The only drug approved for treatment of infection is the antiviral agent ribavirin (American Academy of Pediatrics Committee on Infectious Diseases, 1993, Pediatrics 92:501-504). It has been shown to be effective in the treatment of RSV pneumonia and bronchiolitis, modifying the course of severe RSV disease in immunocompetent children (Smith et al., 1991, New Engl. J. Med. 325:24-29). However, ribavirin has had limited use because it requires prolonged aerosol administration and because of concerns about its potential risk to pregnant women who may be exposed to the drug during its administration in hospital settings.

While a vaccine might prevent RSV infection, no vaccine is yet licensed for this indication. A major obstacle to vaccine development is safety. A formalin-inactivated vaccine, though immunogenic, unexpectedly caused a higher and more severe incidence of lower respiratory tract disease due to RSV in immunized infants than in infants immunized with a similarly prepared trivalent parainfluenza vaccine (Kim et al., 1969, Am. J. Epidemiol. 89:422-434; and Kapikian et al., 1969, Am. J. Epidemiol. 89:405-421). Several candidate RSV vaccines have been abandoned and others are under development (Murphy et al., 1994, Virus Res. 32:13-36), but even if safety issues are resolved, vaccine efficacy must also be improved. A number of problems remain to be solved. Immunization would be required in the immediate neonatal period since the peak incidence of lower respiratory tract disease occurs at 2-5 months of age. The immaturity of the neonatal immune response together with high titers of maternally acquired RSV antibody may be expected to reduce vaccine immunogenicity in the neonatal period (Murphy et al., 1988, J. Virol. 62:3907-3910; and Murphy et al., 1991, Vaccine 9:185-189). Finally, primary RSV infection and

disease do not protect well against subsequent RSV disease (Henderson et al., 1979, New Engl. J. Med. 300:530-534).

Currently, the only approved approach to prophylaxis of RSV disease is passive immunization. Initial evidence suggesting a protective role for IgG was obtained from observations involving maternal antibody in ferrets (Prince, G.A., Ph.D. diss., University of California, Los Angeles, 1975) and humans (Lambrecht et al, 1976, J. Infect. Dis. 134:211-217; and Glezen et al., 1981, J. Pediatr. 98:708-715). Hemming et al. (Morell et al., eds., 1986, Clinical Use of Intravenous Immunoglobulins, Academic Press, London at pages 285-294) recognized the possible utility of RSV antibody in treatment or prevention of RSV infection during studies involving the pharmacokinetics of an intravenous immune globulin (IVIG) in newborns suspected of having neonatal sepsis. They noted that 1 infant, whose respiratory secretions yielded RSV, recovered rapidly after IVIG infusion. Subsequent analysis of the IVIG lot revealed an unusually high titer of RSV neutralizing antibody. This same group of investigators then examined the ability of hyperimmune serum or immune globulin, enriched for RSV neutralizing antibody, to protect cotton rats and primates against RSV infection (Prince et al., 1985, Virus Res. 3:193-206; Prince et al., 1990, J. Virol. 64:3091-3092; Hemming et al., 1985, J. Infect. Dis. 152:1083-1087; Prince et al., 1983, Infect. Immun. 42:81-87; and Prince et al., 1985, J. Virol. 55:517-520). Results of these studies suggested that RSV neutralizing antibody given prophylactically inhibited respiratory tract replication of RSV in cotton rats. When given therapeutically, RSV antibody reduced pulmonary viral replication both in cotton rats and in a nonhuman primate model. Furthermore, passive infusion of immune serum or immune globulin did not produce enhanced pulmonary pathology in cotton rats subsequently challenged with RSV.

Recent clinical studies have demonstrated the ability of this passively administered RSV hyperimmune globulin (RSV IVIG) to protect at-risk children from severe lower respiratory infection by RSV (Groothius et al., 1993, New Engl. J. Med. 329:1524-1530; and The PREVENT Study Group, 1997, Pediatrics 99:93-99). While this is a major advance in preventing RSV infection, this treatment poses certain limitations in its widespread use. First, RSV IVIG must be infused intravenously over several hours to achieve an effective dose. Second, the concentrations of active material in hyperimmune globulins are insufficient to treat adults at risk or most children with comprised cardiopulmonary function. Third, intravenous infusion necessitates monthly hospital visits during the RSV season. Finally, it may prove difficult to select sufficient donors to produce a hyperimmune globulin for RSV to meet the demand for this product. Currently, only approximately 8% of normal donors have RSV neutralizing antibody titers high enough to qualify for the production of hyperimmune globulin.

One way to improve the specific activity of the immunoglobulin would be to develop one or more highly potent RSV neutralizing monoclonal antibodies (MAbs). Such MAbs should be human or humanized in order to retain favorable pharmacokinetics and to avoid generating a human anti-mouse antibody response, as repeat dosing would be required throughout the RSV season. Two glycoproteins, F and G, on the surface of RSV have been shown to be targets of neutralizing antibodies (Fields et al., 1990, *supra*; and Murphy et al., 1994 , *supra*). These two proteins are also primarily responsible for viral recognition and entry into target cells; G protein binds to a specific cellular receptor and the F protein promotes fusion of the virus with the cell. The F protein is also expressed on the surface of infected cells and is responsible for subsequent fusion with other cells leading to syncytia formation. Thus, antibodies to the F protein may directly neutralize virus or block entry of the virus into the cell or prevent syncytia formation. Although antigenic and structural differences between A and B subtypes have been described for both the G and F proteins, the more significant antigenic differences reside on the G glycoprotein, where amino acid sequences are only 53% homologous and antigenic relatedness is 5% (Walsh et al., 1987, J. Infect. Dis. 155:1198-1204; and Johnson et al., 1987, Proc. Natl. Acad. Sci. USA 84:5625-5629). Conversely, antibodies raised to the F protein show a high degree of cross-reactivity among subtype A and B viruses. Beeler and Coelingh (1989, J. Virol. 7:2941-2950) conducted an extensive analysis of 18 different murine MAbs directed to the RSV F protein. Comparison of the biologic and biochemical properties of these MAbs resulted in the identification of three distinct antigenic sites (designated A, B, and C). Neutralization studies were performed against a panel of RSV strains isolated from 1956 to 1985 that demonstrated that epitopes within antigenic sites A and C are highly conserved, while the epitopes of antigenic site B are variable.

A humanized antibody directed to an epitope in the A antigenic site of the F protein of RSV, SYNAGIS®, is approved for intramuscular administration to pediatric patients for prevention of serious lower respiratory tract disease caused by RSV at recommended monthly doses of 15 mg/kg of body weight throughout the RSV season (November through April in the northern hemisphere). SYNAGIS® is a composite of human (95%) and murine (5%) antibody sequences. See, Johnson et al., 1997, J. Infect. Diseases 176:1215-1224 and U.S. Patent No. 5,824,307, the entire contents of which are incorporated herein by reference. The human heavy chain sequence was derived from the constant domains of human IgG_1 and the variable framework regions of the VH genes or Cor (Press et al., 1970, Biochem. J. 117:641-660) and Cess (Takashi et al., 1984, Proc. Natl. Acad. Sci. USA 81:194-198). The human light chain sequence was derived from the constant domain of Cκ and the variable framework regions of the VL gene K104 with Jκ-4 (Bentley et al., 1980,

Nature 288:5194-5198). The murine sequences derived from a murine monoclonal antibody, Mab 1129 (Beeler et al., 1989, J. Virology 63:2941-2950), in a process which involved the grafting of the murine complementarity determining regions into the human antibody frameworks.

Although SYNAGIS® has been successfully used for the prevention of RSV infection in pediatric patients, multiple intramuscular doses of 15 mg/kg of SYNAGIS™ is required to achieve a prophylactic effect. In pediatric patients less than 24 months of age, the mean half-life of SYNAGIS® has been shown to be 20 days and monthly intramuscular doses of 15 mg/kg have been shown to result in a mean ± standard derivation 30 day serum titer of 37 ± 21 μg/ml after the first injection, 57 ± 41 μg/ml after the second injection, 68 ± 51 μg/ml after the third injection, and 72 ± 50 μg/ml after the fourth injection (The IMpact RSV Study Group, 1998, Pediatrics 102:531-537). Serum concentrations of greater than 30 μg/ml have been shown to be necessary to reduce pulmonary RSV replication by 100 fold in the cotton rat model of RSV infection. However, the administration of multiple intramuscular doses of 15 mg /kg of antibody is inconvenient for the patient. Thus, a need exists for antibodies that immunospecifically bind to a RSV antigen, which are highly potent, have an improved pharmacokinetic profile, and thus have an overall improved therapeutic profile. Further, a need exists for antibodies that immunospecifically bind to a RSV antigen which require less frequent administration.

Citation or discussion of a reference herein shall not be construed as an admission that such is prior art to the present invention.

3. SUMMARY OF THE INVENTION

The present invention is based, in part, on the development of methods for achieving or inducing a prophylactically or therapeutically effective serum titer of an antibody or fragment thereof that immunospecifically binds to a respiratory syncytial virus (RSV) antigen in a mammal by passive immunization with such an antibody or fragment thereof, which methods require lower dosages and/or less frequent administration than previously known methods. The present invention is also based, in part, on the identification of antibodies with higher affinities for a RSV antigen which result in increased efficacy for prophylactic or therapeutic uses such that lower serum titers are prophylactically or therapeutically effective, thereby permitting administration of lower dosages and/or reduced frequency of administration.

The present invention provides methods of preventing, neutralizing, treating and ameliorating one or more symptoms associated with RSV infection in a subject comprising administering to said subject one or more antibodies or fragments thereof which

immunospecifically bind to one or more RSV antigens with high affinity and/or high avidity. Because a lower serum titer of such antibodies or antibody fragments is therapeutically or prophylactically effective than the effective serum titer of known antibodies, lower doses of said antibodies or antibody fragments can be used to achieve a serum titer effective for the prevention, neutralization, treatment and the amelioration of symptoms associated with a RSV infection. The use of lower doses of antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens reduces the likelihood of adverse effects. Further, the high affinity and/or high avidity of the antibodies of the invention or fragments thereof enable less frequent administration of said antibodies or antibody fragments than previously thought to be necessary for the prevention, neutralization, treatment or the amelioration of symptoms associated with a RSV infection.

The present invention also provides antibodies which immunospecifically bind to one or more RSV antigens and have increased *in vivo* half-lives relative to known antibodies such as, *e.g.*, SYNAGIS®. In particular, the present invention encompasses antibodies which immunospecifically bind to one or more RSV antigens and have increased *in vivo* half-lives relative to known antibodies (*e.g.*, SYNAGIS®), said increased half-lives resulting from one or more modifications (*e.g.*, substitutions, deletions, or insertions) in amino acid residues identified to be involved in the interaction of the Fc domain of said antibodies and the FcRn receptor. The present invention also encompasses pegylated antibodies and fragments thereof which immunospecifically bind to one or more RSV antigens and have increased *in vivo* half-lives relative to known antibodies such as, *e.g.*, SYNAGIS®. The increased *in vivo* half-lives of antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens reduce the dosage and/or frequency of administration of said antibodies or fragments thereof to a subject.

The invention encompasses sustained release formulations for the administration of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens to a subject. The sustained release formulations reduce the dosage and/or frequency of administration of said antibodies or antibody fragments to a subject. Further, the sustained release formulations may be administered to maintain a therapeutically or prophylactically effective serum titer which does not exceed a certain maximum serum titer for a certain period of time.

The present invention encompasses methods of delivering one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens directly to the site of RSV infection. In particular, the invention encompasses pulmonary delivery of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens. The improved methods of delivering of one or more antibodies or fragments

thereof which immunospecifically bind to one or more RSV antigens reduce the dosage and/or frequency of administration of said antibodies or antibody fragments to a subject.

The present invention provides antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and have an association rate constant or k_{on} rate (antibody (Ab) + antigen $(Ag) \xrightarrow{k_{on}} Ab-Ag$) of at least $10^5\ M^{-1}s^{-1}$, at least $5 \times 10^5\ M^{-1}s^{-1}$, at least $10^6\ M^{-1}s^{-1}$, at least $5 \times 10^6\ M^{-1}s^{-1}$, at least $10^7\ M^{-1}s^{-1}$, at least $5 \times 10^7\ M^{-1}s^{-1}$, or at least $10^8\ M^{-1}s^{-1}$. In particular, the present invention provides compositions for use in the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection, said compositions comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and have an a k_{on} rate of at least $10^5\ M^{-1}s^{-1}$, at least $5 \times 10^5\ M^{-1}s^{-1}$, at least $10^6\ M^{-1}s^{-1}$, at least $5 \times 10^6\ M^{-1}s^{-1}$, at least $10^7\ M^{-1}s^{-1}$, at least $5 \times 10^7\ M^{-1}s^{-1}$, or at least $10^8\ M^{-1}s^{-1}$.

The present invention provides antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and have a k_{off} rate (antibody (Ab) + antigen $(Ag) \xleftarrow{K_{off}} Ab-Ag$) of less than $10^{-1}\ s^{-1}$, less than $5 \times 10^{-1}\ s^{-1}$, less than $10^{-2}\ s^{-1}$, less than $5 \times 10^{-2}\ s^{-1}$, less than $10^{-3}\ s^{-1}$, less than $5 \times 10^{-3}\ s^{-1}$, less than $10^{-4}\ s^{-1}$, less than $5 \times 10^{-4}\ s^{-1}$, less than $10^{-5}\ s^{-1}$, less than $5 \times 10^{-5}\ s^{-1}$, less than $10^{-6}\ s^{-1}$, less than $5 \times 10^{-6}\ s^{-1}$, less than $10^{-7}\ s^{-1}$, less than $5 \times 10^{-7}\ s^{-1}$, less than $10^{-8}\ s^{-1}$, less than $5 \times 10^{-8}\ s^{-1}$, less than $10^{-9}\ s^{-1}$, less than $5 \times 10^{-9}\ s^{-1}$, or less than $10^{-10}\ s^{-1}$. In particular, the present invention provides compositions for use in the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection, said compositions comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and have a k_{off} rate of less than $10^{-1}\ s^{-1}$, less than $5 \times 10^{-1}\ s^{-1}$, less than $10^{-2}\ s^{-1}$, less than $5 \times 10^{-2}\ s^{-1}$, less than $10^{-3}\ s^{-1}$, less than $5 \times 10^{-3}\ s^{-1}$, less than $10^{-4}\ s^{-1}$, less than $5 \times 10^{-4}\ s^{-1}$, less than $10^{-5}\ s^{-1}$, less than $5 \times 10^{-5}\ s^{-1}$, less than $10^{-6}\ s^{-1}$, less than $5 \times 10^{-6}\ s^{-1}$, less than $10^{-7}\ s^{-1}$, less than $5 \times 10^{-7}\ s^{-1}$, less than $10^{-8}\ s^{-1}$, less than $5 \times 10^{-8}\ s^{-1}$, less than $10^{-9}\ s^{-1}$, less than $5 \times 10^{-9}\ s^{-1}$, or less than $10^{-10}\ s^{-1}$.

The present invention also provides antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and have an affinity constant or K_a (k_{on}/k_{off}) of at least $10^2\ M^{-1}$, at least $5 \times 10^2\ M^{-1}$, at least $10^3\ M^{-1}$, at least $5 \times 10^3\ M^{-1}$, at least $10^4\ M^{-1}$, at least $5 \times 10^4\ M^{-1}$, at least $10^5\ M^{-1}$, at least $5 \times 10^5\ M^{-1}$, at least $10^6\ M^{-1}$, at least $5 \times 10^6\ M^{-1}$, at least $10^7\ M^{-1}$, at least $5 \times 10^7\ M^{-1}$, at least $10^8\ M^{-1}$, at least $5 \times 10^8\ M^{-1}$, at least $10^9\ M^{-1}$, at least $5 \times 10^9\ M^{-1}$, at least $10^{10}\ M^{-1}$, at least $5 \times 10^{10}\ M^{-1}$, at least $10^{11}\ M^{-1}$, at least $5 \times 10^{11}\ M^{-1}$, at least $10^{12}\ M^{-1}$, at least $5 \times 10^{12}\ M^{-1}$, at least $10^{13}\ M^{-1}$, at least $5 \times 10^{13}\ M^{-1}$, at least $10^{14}\ M^{-1}$, at least $5 \times 10^{14}\ M^{-1}$, at least $10^{15}\ M^{-1}$, or at least $5 \times 10^{15}\ M^{-1}$. In particular, the present invention provides compositions for use in the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection, said compositions

comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and have a K_a of at least 10^2 M^{-1}, at least 5 X 10^2 M^{-1}, at least 10^3 M^{-1}, at least 5 X 10^3 M^{-1}, at least 10^4 M^{-1}, at least 5 X 10^4 M^{-1}, at least 10^5 M^{-1}, at least 5 X 10^5 M^{-1}, at least 10^6 M^{-1}, at least 5 X 10^6 M^{-1}, at least 10^7 M^{-1}, at least 5 X 10^7 M^{-1}, at least 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1}.

The present invention provides antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and have a median effective concentration (EC_{50}) of less than 0.01 nM, less than 0.025 nM, less than 0.05 nM, less than 0.1 nM, less than 0.25 nM, less than 0.5 nM, less than 0.75 nM, less than 1 nM, less than 1.25 nM, less than 1.5 nM, less than 1.75 nM, or less than 2 nM, in an *in vitro* microneutralization assay. In particular, the present invention provides compositions for use in the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection, said compositions comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and have an EC_{50} of less than 0.01 nM, less than 0.025 nM, less than 0.05 nM, less than 0.1 nM, less than 0.25 nM, less than 0.5 nM, less than 0.75 nM, less than 1 nM, less than 1.25 nM, less than 1.5 nM, less than 1.75 nM, or less than 2 nM, in an *in vitro* microneutralization assay.

The present invention also provides antibodies or fragments thereof comprising a VH domain having the amino acid sequence of any VH domain listed in Table 2 and compositions comprising said antibodies or antibody fragments for use in the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection. The present invention also provides antibodies or fragments thereof comprising one or more VH complementarity determining regions (CDRs) having the amino acid sequence of one or more VH CDRs listed in Table 2 and/or Table 3 and compositions comprising said antibodies or antibody fragments for use in the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection. The present invention also provides antibodies or fragments thereof comprising a VL domain having the amino acid sequence of any VL domain listed in Table 2. The present invention also provides antibodies or fragments thereof comprising one or more VL CDRs having the amino acid sequence of one or more VL CDRs listed in Table 2 and/or Table 3 and compositions comprising said antibodies or antibody fragments for use in the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection. The present invention further provides antibodies comprising a VH domain and a VL domain having the amino acid sequence of

any VH domain and VL domain listed in Table 2 and compositions comprising said antibodies or antibody fragments for use in the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection. The present invention further provides antibodies comprising one or more VH CDRs and one or more VL CDRs having the amino acid sequence of one or more VH CDRs and one or more VL CDRs listed in Table 2 and/or 3 and compositions comprising said antibodies or antibody fragments for use in the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection. In the above embodiments, preferably the antibody binds immunospecifically to a RSV antigen.

The present invention also encompasses methods for achieving a serum titer of at least 40 μg/ml of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens in a mammal, preferably a primate and most preferably a human. In particular, the present invention provides methods for achieving a serum titer of at least 40 μg/ml (preferably at least 75 μg/ml, more preferably at least 100 μg/ml, and most preferably at least 150 μg/ml) of an antibody or fragment thereof that immunospecifically binds to a RSV antigen in a non-primate mammal, comprising administering a dose of less than 2.5 mg/kg (preferably 1.5 mg/kg or less) of the antibody or antibody fragment to the non-primate mammal and measuring the serum titer of the antibody or antibody fragment at least 1 day after administering the dose to the non-primate mammal. The present invention also provides methods for achieving a serum titer of at least 150 μg/ml (preferably at least 200 μg/ml) of an antibody or fragment thereof that immunospecifically binds to a RSV antigen in a non-primate mammal, comprising administering a dose of approximately 5 mg/kg of the antibody or antibody fragment to the non-primate mammal and measuring the serum titer of the antibody or antibody fragment at least 1 day after the administration of the dose to the non-primate mammal.

The present invention also provides methods for achieving a serum titer of at least 40 μg/ml of an antibody or fragment thereof that immunospecifically binds to a RSV antigen in a primate, comprising administering a first dose of 10 mg/kg (preferably 5 mg/kg or less and more preferably 1.5 mg/kg or less) of the antibody or antibody fragment to the primate and measuring the serum titer of the antibody or antibody fragment 20 days (preferably 25, 30, 35 or 40 days) after administrating the first dose to the primate and prior to the administration of any subsequent dose. The present invention also provides methods for achieving a serum titer of at least 75 μg/ml (preferably at least 100 μg/ml, at least 150 μg/ml, or at least 200 μg/ml) of an antibody or fragment thereof that immunospecifically binds to a RSV antigen in a primate, comprising administering a first dose of approximately 15 mg/kg of the antibody or antibody fragment to the primate and measuring

the serum titer of the antibody or antibody fragment 20 days (preferably 25, 30, 35 or 40 days) after administering the first dose to the primate but prior to any subsequent dose.

The present invention also provides methods for preventing, treating, or ameliorating one or more symptoms associated with a RSV infection in a human subject, said methods comprising administering to said human subject at least a first dose of approximately 15 mg/kg of an antibody or fragment thereof that immunospecifically binds to a RSV antigen so that said human subject has a serum antibody titer of at least 75 μg/ml, preferably at least 100 μg/ml, at least 150 μg/ml, or at least 200 μg/ml 30 days after the administration of the first dose of the antibody or antibody fragment and prior to the administration of a subsequent dose. The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a human subject, said methods comprising administering to said human subject at least a first dose of less than 15 mg/kg (preferably 10 mg/kg or less, more preferably 5 mg/kg or less, and most preferably 1.5 mg/kg or less) of an antibody or fragment thereof that immunospecifically binds to a RSV antigen so that said human subject has a serum antibody titer of at least 75 μg/ml, preferably at least 100 μg/ml, at least 150 μg/ml, or at least 200 μg/ml 30 days after the administration of the first dose of the antibody or antibody fragment and prior to the administration of a subsequent dose. The present invention further provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a human subject, said methods comprising administering to said human subject a first dose of an antibody or fragment thereof that immunospecifically binds to a RSV antigen such that a prophylactically or therapeutically effective serum titer of less than 10 μg/ml is achieved no more than 30 days after administering the antibody or antibody fragment.

The present invention provides methods for achieving a therapeutically or prophylactically effective serum titer in a mammal, said methods comprising administering to said mammal an antibody or fragment thereof which immunospecifically binds to a RSV antigen and which has a k_{on} rate (antibody (Ab) + antigen $(Ag) \xrightarrow{k_{on}} Ab-Ag$) of at least 2.5 x $10^{-5}M^{-1}$ s', preferably at least 3 x $10^{5}M^{-1}$ s^{-1}, at least 5 x $10^{5}M^{-1}$ s^{-1}, at least $10^{6}M^{-1}$ s^{-1}, at least 5 x$10^{6}M^{-1}$ s^{-1}, at least $10^{7}M^{-1}$ s^{-1}, at least 5 x$10^{7}M^{-1}$ s^{-1} or at least $10^{8}M^{-1}$ s^{-1}. In particular, the present invention provides methods for achieving a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period, comprising administering to a mammal an antibody or fragment thereof which immunospecifically binds to a RSV antigen and

which has a k_{on} rate of at least 2.5 X 10^5 $M^{-1}s^{-1}$, preferably at least 3 X 10^5 $M^{-1}s^{-1}$, at least 5 X 10^5 $M^{-1}s^{-1}$, at least 10^6 $M^{-1}s^{-1}$, at least 5 X 10^6 $M^{-1}s^{-1}$, at least 10^7 $M^{-1}s^{-1}$, at least 5 X 10^7 $M^{-1}s^{-1}$, or at least 10^8 $M^{-1}s^{-1}$. Preferably, the antibody or antibody fragment has a higher k_{on} rate than SYNAGIS®.

The present invention also provides methods of neutralizing RSV using an antibody or fragment thereof which immunospecifically bind to a RSV antigen and which has a k_{on} rate of at least 2.5 X 10^5 $M^{-1}s^{-1}$, preferably at least 3 X 10^5 $M^{-1}s^{-1}$, at least 5 X 10^5 $M^{-1}s^{-1}$, at least 10^6 $M^{-1}s^{-1}$, at least 5 X 10^6 $M^{-1}s^{-1}$, at least 10^7 $M^{-1}s^{-1}$, at least 5 X 10^7 $M^{-1}s^{-1}$, or at least 10^8 $M^{-1}s^{-1}$ to achieve a prophylactically or therapeutically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) 20, 25, 30, or 35 days after administration without any other dosage administration. Preferably, the antibody or antibody fragment has a higher k_{on} rate than SYNAGIS®.

The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, said methods comprising administering to said mammal, a dose of less than 15 mg/kg (preferably 5 mg/kg or less, more preferably 3 mg/kg or less, and most preferably 1.5 mg/kg or less) of an antibody or fragment thereof which immunospecifically binds to a RSV antigen and has a k_{on} rate of at least 2.5 X 10^5 $M^{-1}s^{-1}$, preferably at least 3 X 10^5 $M^{-1}s^{-1}$, at least 5 X 10^5 $M^{-1}s^{-1}$, at least 10^6 $M^{-1}s^{-1}$, at least 5 X 10^6 $M^{-1}s^{-1}$, at least 10^7 $M^{-1}s^{-1}$, at least 5 X 10^7 $M^{-1}s^{-1}$, or at least 10^8 $M^{-1}s^{-1}$. Preferably, the antibody or antibody fragment has a higher k_{on} rate for the RSV F glycoprotein than SYNAGIS®.

The present invention also provides methods for achieving a therapeutically or prophylactically effective serum titer in a mammal, said methods comprising administering to said mammal an antibody or fragment thereof which immunospecifically binds to a RSV antigen and which has a K_{off} rate (antibody (Ab) + antigen $(Ag) \overset{K_{off}}{\leftarrow} Ab-Ag$) of less than 6.5 x 10^{-4} sec^{-1}, less than 5 x 10^{-4} sec^{-1}, less than 3 x 10^{-4} sec^{-1}, less than 2 x 10^{-4} sec^{-1}, less than 1 x 10^{-4} sec^{-1}, or less than 5 x 10^{-3} sec^{-1}. In particular, the present invention provides methods for achieving a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period, comprising administering to a mammal an antibody or fragment thereof which immunospecifically binds to a RSV antigen and which has a K_{off} rate of less than 6.5 x 10^{-4} sec^{-1}, less than 5 x 10^{-4} sec^{-1}, less than 3 x 10^{-4} sec^{-1}, less than 2 x 10^{-4} sec^{-1}, less than 1 x 10^{-4}

sec^{-1}, or less than 3×10^{-3} sec^{-1}. Preferably, the antibody or fragment thereof has a lower K_{off} rate than SYNAGIS®.

The present invention also provides methods of neutralizing RSV using an antibody or antibody fragment thereof which immunospecifically binds to a RSV antigen and which has a K_{off} rate of less than 6.5×10^{-4} sec^{-1}, less than 5×10^{-4} sec^{-1}, less than 3×10^{-4} sec^{-1}, less than 2×10^{-4} sec^{-1}, less than 1×10^{-4} sec^{-1}, or less than 5×10^{-3} sec^{-1} to achieve a prophylactically or therapeutically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) 20, 25, 30, or 35 days after administration without any other dosage administration. Preferably, the antibody or antibody fragment has a lower K_{off} than SYNAGIS®.

The present invention also provides methods for preventing, treating, or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, said methods comprising administering to a said mammal a dose of less than 15 mg/kg (preferably 5 mg/kg or less, more preferably 3 mg/kg or less, and most preferably 1.5 mg/kg or less) of an antibody or a fragment thereof which immunospecifically binds to a RSV antigen and which has a K_{off} rate of less than 6.5×10^{-4} sec^{-1}, less than 5×10^{-4} sec^{-1}, less than 3×10^{-4} sec^{-1}, less than 2×10^{-4} sec^{-1}, less than 1×10^{-4} sec^{-1}, or less than 5×10^{-3} sec^{-1}. Preferably, the antibody or antibody fragment has a lower K_{off} rate than SYNAGIS®.

The present invention also provides methods for achieving a therapeutically or prophylactically effective serum titer in a mammal, said methods comprising administering to said mammal an antibody or fragment thereof which immunospecifically binds to a RSV antigen and which has an EC_{50} of less than 0.01 nM, less than 0.025 nM, less than 0.05 nM, less than 0.1 nM, less than 0.25 nM, less than 0.5 nM, less than 0.75 nM, less than 1 nM, less than 1.25 nM, less than 1.5 nM, less than 1.75 nM, or less than 2 nM, in an *in vitro* microneutralization assay. In particular, the present invention provides methods for achieving a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period, comprising administering to a mammal an antibody or fragment thereof which immunospecifically binds to a RSV antigen and which has an EC_{50} of less than 0.01 nM, less than 0.025 nM, less than 0.05 nM, less than 0.1 nM, less than 0.25 nM, less than 0.5 nM, less than 0.75 nM, less than 1 nM, less than 1.25 nM, less than 1.5 nM, less than 1.75

nM, or less than 2 nM, in an *in vitro* microneutralization assay. Preferably, the antibody or antibody fragment has a lower EC_{50} than SYNAGIS®.

The present invention also provides methods of neutralizing RSV using an antibody or fragment thereof which immunospecifically binds to a RSV antigen and which has an EC_{50} of less than 0.01 nM, less than 0.025 nM, less than 0.05 nM, less than 0.1 nM, less than 0.25 nM, less than 0.5 nM, less than 0.75 nM, less than 1 nM, less than 1.25 nM, less than 1.5 nM, less than 1.75 nM, or less than 2 nM, in an *in vitro* microneutralization assay to achieve a prophylactically or therapeutically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) 20, 25, 30, or 35 days after administration without any other dosage administration. Preferably, the antibody or antibody fragment has a lower EC_{50} than SYNAGIS®.

The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, said methods comprising administering to said mammal a dose of less than 15 mg/kg (preferably 5 mg/kg or less, more preferably 3 mg/kg or less, and most preferably 1.5 mg/kg or less) of an antibody or a fragment thereof which immunospecifically binds to a RSV antigen and which has an EC_{50} of less than 0.01 nM, less than 0.025 nM, less than 0.05 nM, less than 0.1 nM, less than 0.25 nM, less than 0.5 nM, less than 0.75 nM, less than 1 nM, less than 1.25 nM, less than 1.5 nM, less than 1.75 nM, or less than 2 nM, in an *in vitro* microneutralization assay. Preferably, the antibody or antibody fragment has a lower EC_{50} than SYNAGIS®.

The present invention provides methods for achieving a therapeutically or prophylactically effective serum titer in a mammal, said methods comprising administering to said mammal an antibody or fragment thereof which immunospecifically binds to a RSV antigen and which has an affinity constant (K_a) for a RSV antigen of at least 2 X 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1}. In particular, the present invention also provides methods for achieving a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period, comprising administering to a mammal an antibody or fragment thereof that has an affinity constant (K_a) for a RSV antigen of at least 2 X10^8 M^{-1}, at least 2.5 X10^8 M^{-1}, at least 5 X10^8 M^{-1}, at

least 10^9 M^{-1}, at least 5 $X10^9$ M^{-1}, at least 10^{10} M^{-1}, at least 5 $X10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least 5 $X10^{11}$ M^{-1}, at least 10^{12} M^{-1}, at least 5 $X10^{12}$ M^{-1}, at least 10^{13} M^{-1}, at least $5X10^{13}$ M^{-1}, at least 10^{14} M^{-1}, at least 5 $X10^{14}$ M^{-1}, at least 10^{15} M^{-1}, or at least 5 $X10^{15}$ M^{-1}. Preferably, the antibody or antibody fragment has a higher affinity for a RSV F glycoprotein than SYNAGIS®.

The present invention also provides methods of achieving a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period, comprising administering to a mammal an antibody or fragment thereof which immunospecifically binds to a RSV antigen with a higher avidity than known antibodies such as, *e.g.*, SYNAGIS®.

The present invention also provides methods of neutralizing RSV using an antibody or fragment thereof that has an affinity constant (K_a) for a RSV antigen of at least 2 $X10^8$ M^{-1}, at least 2.5 $X10^8$ M^{-1}, at least 5 $X10^8$ M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1} to achieve a prophylactically or therapeutically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is at least 2 μg/ml and more preferably at least 6 μg/ml) 20, 25, 30, or 35 days after administration without any other dosage administration. Preferably, the antibody or antibody fragment has a higher affinity for the RSV F glycoprotein than SYNAGIS®. The present invention also provides methods of neutralizing RSV using an antibody or fragment thereof that has a higher avidity than known antibodies such as, *e.g.*, SYNAGIS®.

The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, said methods comprising administering to said mammal a dose of less than 15 mg/kg (preferably 5 mg/kg or less, more preferably 3 mg/kg or less, and most preferably 1.5 mg/kg or less) of an antibody or fragment thereof that has an affinity constant (K_a) for a RSV antigen of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1}. Preferably, the antibody or antibody fragment has a higher affinity for the RSV F glycoprotein than SYNAGIS®. The present invention also provides methods for preventing, treating or ameliorating one or

more symptoms associated with a RSV infection in a mammal, preferably a human, said methods comprising administering to said mammal a first dose of less than 15 mg/kg (preferably 5 mg/kg or less, more preferably 3 mg/kg or less, and most preferably 1.5 mg/kg or less) of an antibody or fragment thereof that has a higher avidity than known antibodies such as, *e.g.*, SYNAGIS®.

The present invention encompasses methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, comprising administering to said mammal a first dose of a prophylactically or therapeutically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS®, wherein said effective amount is less than 15 mg/kg (preferably 5 mg/kg or less, more preferably 3 mg/kg or less, and most preferably 1.5 mg/kg or less) of said antibodies or antibody fragments which dose results in a serum titer of less than 30 μg/ml (which is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) at least 20 days (preferably at least 25, at least 30, or at least 35 days) after the administration of the first dose and prior to the administration of a subsequent dose. In particular, the present invention provides methods for preventing, treating, or ameliorating one or more symptoms associated with a RSV infection in a human subject, comprising administering to said human subject a first dose of less than 5 mg/kg (preferably 3 mg/kg or less, and most preferably 1.5 mg/kg) of an antibody or fragment thereof that immunospecifically binds to a RSV antigen with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-1}, at least $5 X 10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least $5 X 10^{11}$ M^{-1}, at least 10^{12} M^{-1}, or at least $5 X 10^{12}$ M^{-1}) so that said human subject has a serum antibody titer of less than 30 μg/ml (which is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) at least 20 days (preferably at least 25, at least 30, or at least 35 days) after the administration of the first dose of the antibody or antibody fragment and prior to the administration of a subsequent dose.

The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said methods comprising administering to said mammal a first dose of one or more antibodies or fragments thereof comprising a VH domain having an amino acid sequence of any VH domain listed in Table 2 to achieve a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain

number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period. The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said methods comprising administering to said mammal a first dose of one or more antibodies or fragments thereof comprising one or more VH complementarity determining regions (CDRs) having the amino acid sequence of one or more VH CDRs listed in Table 2 and/or Table 3 to achieve a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period. Preferably, said antibodies or antibody fragments immunospecifically bind to a RSV antigen.

The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said methods comprising administering to said mammal a first dose of one or more antibodies or fragments thereof comprising a VL domain having the amino acid sequence of any VL domain listed in Table 2 to achieve a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period. The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said methods comprising administering to said mammal a first dose of one or more antibodies or fragments thereof comprising one or more VL CDRs having the amino acid sequence of one or more VL CDRs listed in Table 2 and/or Table 3 to achieve a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period. Preferably, said antibodies or antibody fragments immunospecifically bind to a RSV antigen.

The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said methods comprising administering to said mammal a first dose of one or more antibodies or fragments thereof comprising a VH domain and a VL domain having the amino acid sequence of any VH domain and VL domain listed in Table 2 to achieve a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30

μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period. The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said methods comprising administering to said mammal a first dose of one or more antibodies or fragments thereof comprising one or more VH CDRs and one or more VL CDRs having the amino acid sequence of one or more VH CDRs and one or more VL CDRs listed in Table 2 and/or 3 to achieve a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period. Preferably, said antibodies or antibody fragments immunospecifically bind to a RSV antigen.

In a specific embodiment, the present invention provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said methods comprising administering to said mammal a first dose of one or more antibodies or fragments thereof comprising a VH domain having an amino acid sequence of SEQ ID NO:11, 21, 31, 43, 51, 56, 61, 65, 70, 74, 85, 89, or 91 and/or a VL domain having an amino acid sequence of SEQ ID NO:14, 23, 25, 28, 35, 37, 40, 47, 53, 57, 62, 67, 71, 76, 87, 90, or 94 to achieve a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period. In a preferred embodiment, the present invention provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said methods comprising administering to said mammal a first dose of one or more antibodies or fragments thereof comprising a VH domain having an amino acid sequence of SEQ ID NO:43, 51, 56, 61, 65, 74, 85, 89, or 93 and/or a VL domain having an amino acid sequence of SEQ ID NO:47, 53, 57, 62, 67, 76, 87, 90, or 94 to achieve a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period. In another embodiment, the present invention provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said methods comprising administering to said mammal a first dose of one or more antibodies or

fragments thereof comprising a VH CDR3 having an amino acid sequence of SEQ ID NO:46 or 45 and a VL CDR3 having an amino acid sequence of SEQ ID NO:6 to a therapeutically or prophylactically effective serum titer, wherein said effective serum titer is less than 30 μg/ml (and is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) after a certain number of days (for example, but not limited to, 20, 25, 30 or 35 days) without any other dosing within that period.

The present invention also provides compositions comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and which have increased *in vivo* half-lives compared to known anti-RSV antibodies as a result of, *e.g.*, one or more modifications in amino acid residues identified to be involved in the interaction between the Fc domain of said antibodies or antibody fragments and the FcRn receptor. In one embodiment, a composition of the invention comprises HL-SYNAGIS or an antigen-binding fragment thereof. In another embodiment, a composition of the invention comprises one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with a higher avidity and/or a higher affinity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-1}, at least $5 X 10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least $5 X 10^{11}$ M^{-1}, at least 10^{12} M^{-1}, or at least $5 X 10^{12}$ M^{-1} for a RSV antigen) and which comprise an Fc domain with increased affinity for the FcRn receptor relative to the Fc domain of SYNAGIS®. In accordance with this embodiment, the increased affinity of the Fc domain of said antibodies or antibody fragments results in an *in vivo* half-life of said antibodies or antibody fragments of at least 25 days, preferably at least 30 days, more preferably at least 30 days, and most preferably at least 40 days. In another embodiment, a composition of the invention comprises HL-SYNAGIS or an antigen-binding fragment thereof and one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and which comprise an Fc domain with increased affinity for the FcRn receptor relative to the Fc domain of SYNAGIS®.

The present invention also provides compositions comprising one or more pegylated antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens. In one embodiment, a composition of the invention comprises pegylated SYNAGIS® or a fragment thereof. In another embodiment, a composition of the invention comprises one or more pegylated antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS®. In yet another embodiment, a composition of the invention comprises pegylated SYNAGIS® or an antigen-binding fragment thereof and one

or more pegylated antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS®.

The present invention also provides compositions comprising one or more pegylated antibodies or fragments thereof which comprise an Fc domain with increased affinity for the FcRn receptor relative to the Fc domain of SYNAGIS®. In one embodiment, a composition of the invention comprises a pegylated HL-SYNAGIS or an antigen-binding fragment thereof. In another embodiment, a composition of the invention comprises one or more pegylated antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with a higher avidity and/or a higher affinity than known such as, *e.g.*, SYNAGIS® and which comprise an Fc domain with increased affinity for the FcRn receptor relative to the Fc domain of SYNAGIS®

The present invention encompasses methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, comprising administering to said mammal a first dose of a prophylactically or therapeutically effective amount of HL-SYNAGIS or an antigen-binding fragment thereof, wherein said effective amount is approximately 15 mg/kg of said antibodies or fragments thereof which dose results in a serum titer of at least 30 μg/ml at least 30 days after the administration of the first dose and prior to the administration of a subsequent dose. In particular, the present invention provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a human subject, comprising administering to said human subject a first dose of 15 mg/kg of HL-SYNAGIS or an antigen-binding fragment thereof so that said human subject has a serum antibody titer of at least 30 μg/ml at least 30 days after the administration of the first dose of the antibody or antibody fragment and prior to the administration of a subsequent dose.

The present invention also encompasses methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, comprising administering to said mammal a first dose of a prophylactically or therapeutically effective amount of one or more antibodies or fragments thereof which have increased *in vivo* half-lives and which immunospecifically bind to one or more RSV antigens with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-1}, at least $5 X 10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least $5 X 10^{11}$ M^{-1}, at least 10^{12} M^{-1}, or at least $5 X 10^{12}$ M^{-1} for a RSV antigen), wherein said effective amount is less than 15 mg/kg (preferably 5 mg/kg or less, more preferably 3 mg/kg or less, and most preferably 1.5

mg/kg or less) of said antibodies or fragments thereof which dose results in a serum titer of less than 30 μg/ml (which is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) at least 20 days (preferably at least 25, at least 30, or at least 35 days) after the administration of the first dose and prior to the administration of a subsequent dose. In particular, the present invention provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a human subject, comprising administering to said human subject a first dose of less than 5 mg/kg (preferably 1.5 mg/kg or less) of an antibody or a fragment thereof which has an increased *in vivo* half-life and which immunospecifically binds to a RSV antigen with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-1}, at least $5 X 10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least $5 X 10^{11}$ M^{-1}, at least 10^{12} M^{-1}, or at least $5 X 10^{12}$ M^{-1} for a RSV antigen) so that said human subject has a serum antibody titer of less than 30 μg/ml (which is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) at least 25 days (preferably at least 30, at least 35, or at least 40 days) after the administration of the first dose of the antibody or antibody fragment and prior to the administration of a subsequent dose.

The present invention provides sustained release formulations comprising one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens. In one embodiment, a sustained release formulation comprises SYNAGIS® or a fragment thereof. In another embodiment, a sustained release formulation comprises one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-1}, at least $5 X 10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least $5 X 10^{11}$ M^{-1}, at least 10^{12} M^{-1}, or at least $5 X 10^{12}$ M^{-1} for a RSV antigen). In another embodiment, a sustained release formulation comprises SYNAGIS® or an antigen-binding fragment thereof and one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-1}, at least $5 X 10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least $5 X 10^{11}$ M^{-1}, at least 10^{12} M^{-1}, or at least $5 X 10^{12}$ M^{-1} for a RSV antigen). In another embodiment, HL-SYNAGIS or an antigen-binding fragment thereof is formulated in as sustained release formulation. In yet another embodiment, antibodies or

fragments thereof which have higher avidity and/or higher affinity for one or more RSV antigens than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, or at least 5 X 10^{12} M^{-1} for a RSV antigen) and which comprises an Fc domain with increased affinity for the FcRn receptor relative to the Fc domain of SYNAGIS® are formulated in sustained release formulations.

The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, comprising administering to said mammal a first dose of a prophylactically or therapeutically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens in a sustained release formulation, wherein said effective amount is a dose of 15 mg/kg or less of said antibodies or fragments thereof, which dose, preferably results in a serum titer of at least 2 μg/ml (preferably at least 5 μg/ml, at least 10 μg/ml, at least 20 μg/ml, at least 30 μg/ml, or at least 40 μg/ml) for at least 20 days (preferably at least 25, 30, 35 or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose.

In one embodiment, a mammal, preferably a human, is administered a first dose of a prophylactically or therapeutically effective amount of SYNAGIS® or an antigen-binding fragment thereof in a sustained release formulation, wherein said effective amount is a dose of approximately 15 mg/kg of SYNAGIS® or an antigen-binding fragment thereof which dose results in a serum titer of at least 20 μg/ml (preferably at least 30 μg/ml, more preferably at least 40 μg/ml, and most preferably at least 50 μg/ml) for at least 30 days (preferably at least 35 days, more preferably at least 40 days, and most preferably at least 45 days) after the administration of the first dose and prior to the administration of a subsequent dose. In a preferred embodiment, a mammal, preferably a human, is administered a first dose of a prophylactically or therapeutically effective amount of SYNAGIS® or an antigen-binding fragment thereof in a sustained release formulation, wherein said effective amount is a dose of 15 mg/kg or less of SYNAGIS® or an antigen-binding fragment thereof which dose results in a serum titer of 20 μg/ml (preferably at least 30 μg/ml, more preferably at least 40 μg/ml, and most preferably at least 50 μg/ml) at least 30 days (preferably at least 35 days, more preferably at least 40 days, and most preferably at least 45 days) after the administration of the first dose and prior to the administration of a subsequent dose.

In another embodiment, a mammal, preferably a human, is administered a first dose of a prophylactically or therapeutically effective amount of one or more antibodies or

fragments thereof which immunospecifically bind to one or more RSV antigens with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, or at least 5 X 10^{12} M^{-1} for a RSV antigen) in a sustained release formulation, wherein said effective amount is a dose of less than 15 mg/kg (preferably 5 mg/kg or less, more preferably 3 mg/kg or less, and most preferably 1.5 mg/kg or less) of said antibodies or antibody fragments which dose results in a serum titer of less than 30 μg/ml (which is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) for at least 20 days (preferably at least 25, at least 30, at least 35, or at least 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. In a preferred embodiment, a mammal, preferably a human, is administered a first dose of a prophylactically or therapeutically effective amount of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, or at least 5 X 10^{12} M^{-1} for a RSV antigen) in a sustained release formulation, wherein said effective amount is a dose of less than 15 mg/kg of said antibodies or antibody fragments which dose results in a serum titer of 10 μg/ml for at least 20 days (preferably at least 25, at least 30, at least 35 or at least 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. In accordance with this embodiment, the prophylactically or therapeutically effective amount of the dose of the antibodies or antibody fragments is approximately 0.5 mg/kg, preferably 1 mg/kg, 1.5 mg/kg, 3 mg/kg, 5 mg/kg, 7.5 mg/kg, 10 mg/kg, 12 mg/kg, or 14 mg/kg. In another preferred embodiment, a mammal, preferably a human, is administered a first dose of a prophylactically or therapeutically effective amount of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with higher avidity and/or higher affinity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, or at least 5 X 10^{12} M^{-1} for a RSV antigen) in a sustained release formulation, wherein said effective amount is a dose of 1.5 mg/kg of said antibodies or antibody fragments which dose results in a serum titer of 10 μg/ml for at least 20 days

(preferably at least 25, at least 30, at least 35, or at least 40 days) after the administration of the first dose and prior to the administration of a subsequent dose.

Additionally, the present invention provides sustained release compositions comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens, which sustained release compositions maintain a certain serum titer in a subject for a certain period of time without exceeding a particular serum titer. In one embodiment, a sustained release formulation comprising SYNAGIS® or an antigen-binding fragment thereof maintains a serum titer in a mammal, preferably a human, of approximately 25 μg/ml (preferably 30 μg/ml, more preferably 40 μg/ml, and most preferably 50 μg/ml) without exceeding a serum titer of approximately 100 μg/ml (preferably 75 μg/ml) for at least 20 days (preferably at least 25, 30, 35, or 40 days). In another embodiment, a sustained release formulation comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with a higher avidity and/or a higher affinity than previously known antibodies such as, *e.g.*, SYNAGIS®, maintains a serum titer in a mammal, preferably a human, of approximately 2 μg/ml (preferably 6 μg/ml, 10 μg/ml, 20 μg/ml, or 30 μg/ml) without exceeding a serum titer of approximately 40 μg/ml (preferably 75 μg/ml) for at least 20 days (preferably at least 25, 30, 35, or 40 days).

The present invention encompasses methods of preventing, treating or ameliorating one or more symptoms of RSV infection in a mammal, preferably a human, by administering sustained release formulations of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens and which have increased *in vivo* half-lives. In one embodiment, a sustained release formulation comprising HL-SYNAGIS or an antigen-binding fragment thereof is administered to a mammal, preferably a human, to prevent, treat, or ameliorate one or more symptoms associated with a RSV infection. In another embodiment, a sustained release formulation comprising one or more antibodies or fragments thereof which have higher avidity and/or higher affinity for one or more RSV antigens than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, or at least 5 X 10^{12} M^{-1} for a RSV antigen) and which comprises an Fc domain with increased affinity for the FcRn receptor relative to the Fc domain of SYNAGIS® are administered to a mammal, preferably a human, to prevent, treat, or ameliorate one or more symptoms associated with a RSV infection.

The present invention also provides pulmonary delivery systems for administering one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens. In particular, the present invention provides compositions for pulmonary delivery, said compositions comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens. SYNAGIS® or an antigen-binding fragment thereof can be incorporated into compositions for pulmonary delivery. HL-SYNAGIS or an antigen-binding fragment thereof can be incorporated into compositions for pulmonary delivery. One or more antibodies or fragments thereof that bind to one or more RSV antigens with higher affinity and/or higher avidity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-1}, at least $5 X 10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least $5 X 10^{11}$ M^{-1}, at least 10^{12} M^{-1}, or at least $5 X 10^{12}$ M^{-1} for a RSV antigen) can be incorporated into compositions for pulmonary delivery. Further, one or more antibodies or fragments thereof which bind to one or more RSV antigens with higher affinity and/or higher avidity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments with an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-1}, at least $5 X 10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least $5 X 10^{11}$ M^{-1}, at least 10^{12} M^{-1}, or at least $5 X 10^{12}$ M^{-1} for a RSV antigen) and which comprise an Fc domain with increased affinity for the FcRn receptor relative to the Fc domain of SYNAGIS® can be incorporated into compositions for pulmonary delivery.

The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection, said methods comprising administering to a mammal, preferably a human, a composition for pulmonary delivery comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens. In particular, the present invention provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection, said methods comprising administering to a mammal, preferably a human, a composition for pulmonary delivery comprising SYNAGIS® or fragments thereof. The present invention also provides methods for preventing, treating or ameliorating one or more symptoms associated with a RSV infection, said methods comprising administering to a mammal, preferably a human, a composition for pulmonary delivery comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with higher affinity and/or higher avidity than known antibodies such as, *e.g.*, SYNAGIS® (*e.g.*, antibodies or antibody fragments having an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-}

$^{-1}$, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, or at least 5 X 10^{12} M^{-1} for one or more RSV antigens).

In one embodiment, a first dose of a prophylactically or therapeutically effective amount of a composition comprising SYNAGIS® or an antigen-binding fragment thereof is administered to the lungs of a mammal, preferably a human, and results in an antibody concentration of at least 20 ng per mg of lung protein (preferably at least 40 ng/mg, at least 60 ng/mg, at least 80 ng/mg, at least 50 ng/mg, at least 75 ng/mg, at least 100 ng/mg, or at least 150 ng/mg) at least 20 days (preferably at least 25, 30, 35 or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, the prophylactically or therapeutically effective amount is a dose of approximately 0.01 mg/kg, (preferably at least 0.1 mg/kg, at least 1 mg/kg, at least 2 mg/kg, at least 4 mg/kg, at least 5 mg/kg or at least 10 mg/kg) of SYNAGIS® or an antigen-binding fragment thereof.

In another embodiment, a first dose of a prophylactically or therapeutically effective amount of a composition comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with higher affinity and/or higher avidity than known antibodies such as, *e.g.*, SYNAGIS®, (*e.g.*, antibodies or antibody fragments having an affinity of at least 2X10^{8} M^{-1}, at least 2.5X10^{8} M^{-1}, at least 5X10^{8} M^{-1}, at least 10^{9} M^{-1}, at least 5 X 10^{9} M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, or at least 5 X 10^{12} M^{-1} for one or more RSV antigens) is administered to the lungs of a mammal, preferably a human and results in an antibody concentration of 20 ng per mg of lung protein (preferably at least 40 ng/mg, at least 60 ng/mg, at least 80 ng/mg, at least 50 ng/mg, at least 75 ng/mg, at least 100 ng/mg, or at least 150 ng/mg) , at least 200 ng/mg, at least 250 ng/mg, at least 500 ng/mg, at least 750 ng/mg, at least 1 μg/mg, at least 2 μg/mg, at least 5 μg/mg, at least 10 μg/mg, at least 15 μg/mg, or at least 25 μg/mg) at least 20 days (preferably at least 25, 30, 35 or 40 days) at least 20 days (preferably at least 25, at least 30, at least 35 or at least 40 days after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, the prophylactically effective amount is a dose of approximately 0.001 mg/kg, (preferably at least 0.005 mg/kg, at least 0.01 mg/kg, at least 0.05 mg/kg, at least 0.1 mg/kg, at least 1 mg/kg, at least 2 mg/kg, at least 4 mg/kg, at least 5 mg/kg or at least 10 mg/kg) of said antibodies or antibody fragments.

The present invention further provides detectable or diagnostic compositions comprising using antibodies or fragments thereof that immunospecifically bind to a RSV antigen, and methods for detecting or diagnosing a RSV infection utilizing said compositions.

3.1. DEFINITIONS

The term "analog" as used herein refers to a polypeptide that possesses a similar or identical function as a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment but does not necessarily comprise a similar or identical amino acid sequence of a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment, or possess a similar or identical structure of a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment. A polypeptide that has a similar amino acid sequence refers to a polypeptide that satisfies at least one of the following: (a) a polypeptide having an amino acid sequence that is at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95% or at least 99% identical to the amino acid sequence of a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment described herein; (b) a polypeptide encoded by a nucleotide sequence that hybridizes under stringent conditions to a nucleotide sequence encoding a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment described herein of at least 5 amino acid residues, at least 10 amino acid residues, at least 15 amino acid residues, at least 20 amino acid residues, at least 25 amino acid residues, at least 40 amino acid residues, at least 50 amino acid residues, at least 60 amino residues, at least 70 amino acid residues, at least 80 amino acid residues, at least 90 amino acid residues, at least 100 amino acid residues, at least 125 amino acid residues, or at least 150 amino acid residues; and (c) a polypeptide encoded by a nucleotide sequence that is at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95% or at least 99% identical to the nucleotide sequence encoding a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment described herein. A polypeptide with similar structure to a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment described herein refers to a polypeptide that has a similar secondary, tertiary or quaternary structure of a RSV polypeptide, a fragment of a RSV, an antibody, or antibody fragment described herein. The structure of a polypeptide can determined by methods known to those skilled in the art, including but not limited to, X-ray crystallography, nuclear magnetic resonance, and crystallographic electron microscopy.

The term "derivative" as used herein refers to a polypeptide that comprises an amino acid sequence of a RSV polypeptide, a fragment of a RSV polypeptide, an antibody that immunospecifically binds to a RSV polypeptide, or an antibody fragment that immunospecifically binds to a RSV polypeptide which has been altered by the introduction of amino acid residue substitutions, deletions or additions. The term "derivative" as used

herein also refers to a RSV polypeptide, a fragment of a RSV polypeptide, an antibody that immunospecifically binds to a RSV polypeptide, or an antibody fragment that immunospecifically binds to a RSV polypeptide which has been modified, *i.e*, by the covalent attachment of any type of molecule to the polypeptide. For example, but not by way of limitation, a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment may be modified, *e.g.*, by glycosylation, acetylation, pegylation, phosphorylation, amidation, derivatization by known protecting/blocking groups, proteolytic cleavage, linkage to a cellular ligand or other protein, etc. A derivative of a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment may be modified by chemical modifications using techniques known to those of skill in the art, including, but not limited to specific chemical cleavage, acetylation, formylation, metabolic synthesis of tunicamycin, etc. Further, a derivative of a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment may contain one or more non-classical amino acids. A polypeptide derivative possesses a similar or identical function as a RSV polypeptide, a fragment of a RSV polypeptide, an antibody, or antibody fragment described herein.

The term "effective neutralizing titer" as used herein refers to the amount of antibody which corresponds to the amount present in the serum of animals (human or cotton rat) that has been shown to be either clinically efficacious (in humans) or to reduce virus by 99% in, for example, cotton rats. The 99% reduction is defined by a specific challenge of, *e.g.*, 10^3 pfu, 10^4 pfu, 10^5 pfu, 10^6 pfu, 10^7 pfu, 10^8 pfu, or 10^9 pfu) of RSV.

The term "epitopes" as used herein refers to portions of a RSV polypeptide having antigenic or immunogenic activity in an animal, preferably a mammal, and most preferably in a human. An epitope having immunogenic activity is a portion of a RSV polypeptide that elicits an antibody response in an animal. An eptiope having antigenic activity is a portion of a RSV polypeptide to which an antibody immunospecifically binds as determined by any method well known in the art, for example, by the immunoassays described herein. Antigenic epitopes need not necessarily be immunogenic.

The term "fragment" as used herein refers to a peptide or polypeptide comprising an amino acid sequence of at least 5 contiguous amino acid residues, at least 10 contiguous amino acid residues, at least 15 contiguous amino acid residues, at least 20 contiguous amino acid residues, at least 25 contiguous amino acid residues, at least 40 contiguous amino acid residues, at least 50 contiguous amino acid residues, at least 60 contiguous amino residues, at least 70 contiguous amino acid residues, at least contiguous 80 amino acid residues, at least contiguous 90 amino acid residues, at least contiguous 100 amino acid residues, at least contiguous 125 amino acid residues, at least 150 contiguous amino acid

residues, at least contiguous 175 amino acid residues, at least contiguous 200 amino acid residues, or at least contiguous 250 amino acid residues of the amino acid sequence of a RSV polypeptide or an antibody that immunospecifically binds to a RSV polypeptide.

The term "human infant" as used herein refers to a human less than 24 months, preferably less than 16 months, less than 12 months, less than 6 months, less than 3 months, less than 2 months, or less than 1 month of age.

The term " human infant born prematurely" as used herein refers to a human born at less than 40 weeks gestational age, preferably less than 35 weeks gestational age, who is less than 6 months old, preferably less than 3 months old, more preferably less than 2 months old, and most preferably less than 1 month old.

An "isolated" or "purified" antibody or fragment thereof is substantially free of cellular material or other contaminating proteins from the cell or tissue source from which the protein is derived, or substantially free of chemical precursors or other chemicals when chemically synthesized. The language "substantially free of cellular material" includes preparations of an antibody or antibody fragment in which the antibody or antibody fragment is separated from cellular components of the cells from which it is isolated or recombinantly produced. Thus, an antibody or antibody fragment that is substantially free of cellular material includes preparations of antibody or antibody fragment having less than about 30%, 20%, 10%, or 5% (by dry weight) of heterologous protein (also referred to herein as a "contaminating protein"). When the antibody or antibody fragment is recombinantly produced, it is also preferably substantially free of culture medium, *i.e.*, culture medium represents less than about 20%, 10%, or 5% of the volume of the protein preparation. When the antibody or antibody fragment is produced by chemical synthesis, it is preferably substantially free of chemical precursors or other chemicals, *i.e.*, it is separated from chemical precursors or other chemicals which are involved in the synthesis of the protein. Accordingly such preparations of the antibody or antibody fragment have less than about 30%, 20%, 10%, 5% (by dry weight) of chemical precursors or compounds other than the antibody or antibody fragment of interest. In a preferred embodiment, antibodies of the invention or fragments thereof are isolated or purified.

An "isolated" nucleic acid molecule is one which is separated from other nucleic acid molecules which are present in the natural source of the nucleic acid molecule. Moreover, an "isolated" nucleic acid molecule, such as a cDNA molecule, can be substantially free of other cellular material, or culture medium when produced by recombinant techniques, or substantially free of chemical precursors or other chemicals when chemically synthesized. In a preferred embodiment, nucleic acid molecules encoding antibodies of the invention or fragments thereof are isolated or purified.

The term "fusion protein" as used herein refers to a polypeptide that comprises an amino acid sequence of an antibody or fragment thereof and an amino acid sequence of a heterologous polypeptide (*e.g.*, a non-anti-RSV antigen antibody).

The term "high potency" as used herein refers to antibodies or fragments thereof that exhibit high potency as determined in various assays for biological activity *(e.g.*, neutralization of RSV) such as those described herein. For example, high potency antibodies of the present invention or fragments thereof have an EC_{50} value less than 0.01 nM, less than 0.025 nM, less than 0.05 nM, less than 0.1 nM, less than 0.25 nM, less than 0.5 nM, less than 0.75 nM, less than 1 nM, less than 1.25 nM, less than 1.5 nM, less than 1.75 nM, or less than 2 nM as measured by a microneutralization assay described herein. Further, high potency antibodies of the present invention or fragments thereof result in at least a 75%, preferably at least a 95% and more preferably a 99% lower RSV titer in a cotton rat 5 days after challenge with 10^5 pfu relative to a cotton rat not administered said antibodies or antibody fragments. In certain embodiments of the invention, high potency antibodies of the present invention or fragments thereof exhibit a high affinity and/or high avidity for one or more RSV antigens (*e.g.*, antibodies or antibody fragments having an affinity of at least $2X10^8$ M^{-1}, at least $2.5X10^8$ M^{-1}, at least $5X10^8$ M^{-1}, at least 10^9 M^{-1}, at least $5 X 10^9$ M^{-1}, at least 10^{10} M^{-1}, at least $5 X 10^{10}$ M^{-1}, at least 10^{11} M^{-1}, at least $5 X 10^{11}$ M^{-1}, at least 10^{12} M^{-1}, or at least $5 X 10^{12}$ M^{-1} for one or more RSV antigens).

The term "host" as used herein refers to a mammal, preferably a human.

The term "host cell" as used herein refers to the particular subject cell transfected with a nucleic acid molecule and the progeny or potential progeny of such a cell. Progeny of such a cell may not be identical to the parent cell transfected with the nucleic acid molecule due to mutations or environmental influences that may occur in succeeding generations or integration of the nucleic acid molecule into the host cell genome.

In certain embodiments of the invention, a "prophylactically effective serum titer" is the serum titer in a mammal, preferably a human, that reduces the incidence of a RSV infection in said mammal. Preferably, the prophylactically effective serum titer reduces the incidence of RSV infections in humans with the greatest probability of complications resulting from RSV infection (*e.g.*, a human with cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency, a human who has had a bone marrow transplant, a human infant, or an elderly human). In certain other embodiments of the invention, a "prophylactically effective serum titer" is the serum titer in a cotton rat that results in a RSV titer 5 days after challenge with 10^5 pfu that is 99% lower than the RSV titer 5 days after challenge with 10^5

pfu of RSV in a cotton rat not administered an antibody or antibody fragment that immunospecifically binds to a RSV antigen.

In certain embodiments of the invention, a "therapeutically effective serum titer" is the serum titer in a mammal, preferably a human, that reduces the severity, the duration and/or the symptoms associated with a RSV infection in said mammal. Preferably, the therapeutically effective serum titer reduces the severity, the duration and/or the number symptoms associated with RSV infections in humans with the greatest probability of complications resulting from a RSV infection (*e.g.*, a human with cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency, a human who has had a bone marrow transplant, a human infant, or an elderly human). In certain other embodiments of the invention, a "therapeutically effective serum titer" is the serum titer in a cotton rat that results in a RSV titer 5 days after challenge with 10^5 pfu that is 99% lower than the RSV titer 5 days after challenge with 10^5 pfu of RSV in a cotton rat not administered an antibody or antibody fragment that immunospecifically binds to a RSV antigen.

As used herein, "HL-SYNAGIS" is SYNAGIS® with one or more modifications in amino acid residues identified to be involved in the interaction between the Fc domain of SYNAGIS® and the FcRn receptor which results in an increase in the *in vivo* half-life of SYNAGIS® to greater than 21 days. An antigen-binding fragment of HL-SYNAGIS is a fragment of SYNAGIS® which immunospecifically binds to RSV F glycoprotein and has one or more modifications in amino acid residues identified to be involved in the interaction between the Fc domain of SYNAGIS® and the FcRn receptor, wherein said modifications result in an increase in the *in vivo* half-life of the antigen-binding fragment. In accordance with the invention, HL-SYNAGIS or an antigen-binding fragment thereof has an *in vivo* half-life of at least 25 days, preferably at least 30 days, more preferably at least 35 days, and most preferably at least 40 days.

The term "RSV antigen" refers to a RSV polypeptide or fragment thereof to which an antibody or antibody fragment immunospecifically binds. An RSV antigen also refers to an analog or derivative of a RSV polypeptide or fragment thereof to which an antibody or antibody fragment immunospecifically binds.

The term "serum titer" as used herein refers to an average serum titer in a population of least 10, preferably at least 20, and most preferably at least 40 subjects.

The term "antibodies or fragments that immunospecifically bind to a RSV antigen" as used herein refers to antibodies or fragments thereof that specifically bind to a RSV polypeptide or a fragment of a RSV polypeptide and do not non-specifically bind to other polypeptides. Antibodies or fragments that immunospecifically bind to a RSV polypeptide

or fragment thereof may have cross-reactivity with other antigens. Preferably, antibodies or fragments that immunospecifically bind to a RSV polypeptide or fragment thereof do not cross-react with other antigens. Antibodies or fragments that immunospecifically bind to a RSV polypeptide can be identified, for example, by immunoassays or other techniques known to those of skill in the art.

To determine the percent identity of two amino acid sequences or of two nucleic acid sequences, the sequences are aligned for optimal comparison purposes (*e.g.*, gaps can be introduced in the sequence of a first amino acid or nucleic acid sequence for optimal alignment with a second amino acid or nucleic acid sequence). The amino acid residues or nucleotides at corresponding amino acid positions or nucleotide positions are then compared. When a position in the first sequence is occupied by the same amino acid residue or nucleotide as the corresponding position in the second sequence, then the molecules are identical at that position. The percent identity between the two sequences is a function of the number of identical positions shared by the sequences (*i.e.*, % identity = number of identical overlapping positions/total number of positions x 100%). In one embodiment, the two sequences are the same length.

The determination of percent identity between two sequences can also be accomplished using a mathematical algorithm. A preferred, non-limiting example of a mathematical algorithm utilized for the comparison of two sequences is the algorithm of Karlin and Altschul, 1990, Proc. Natl. Acad. Sci. U.S.A. 87:2264-2268, modified as in Karlin and Altschul, 1993, Proc. Natl. Acad. Sci. U.S.A. 90:5873-5877. Such an algorithm is incorporated into the NBLAST and XBLAST programs of Altschul et al., 1990, J. Mol. Biol. 215:403. BLAST nucleotide searches can be performed with the NBLAST nucleotide program parameters set, *e.g.*, for score=100, wordlength=12 to obtain nucleotide sequences homologous to a nucleic acid molecules of the present invention. BLAST protein searches can be performed with the XBLAST program parameters set, *e.g.*, to score-50, wordlength=3 to obtain amino acid sequences homologous to a protein molecule of the present invention. To obtain gapped alignments for comparison purposes, Gapped BLAST can be utilized as described in Altschul et al., 1997, Nucleic Acids Res. 25:3389-3402. Alternatively, PSI-BLAST can be used to perform an iterated search which detects distant relationships between molecules (*Id.*). When utilizing BLAST, Gapped BLAST, and PSI-Blast programs, the default parameters of the respective programs (*e.g.*, of XBLAST and NBLAST) can be used (see, *e.g.*, http://www.ncbi.nlm.nih.gov). Another preferred, non-limiting example of a mathematical algorithm utilized for the comparison of sequences is the algorithm of Myers and Miller, 1988, CABIOS 4:11-17. Such an algorithm is incorporated in the ALIGN program (version 2.0) which is part of the GCG sequence

alignment software package. When utilizing the ALIGN program for comparing amino acid sequences, a PAM120 weight residue table, a gap length penalty of 12, and a gap penalty of 4 can be used.

The percent identity between two sequences can be determined using techniques similar to those described above, with or without allowing gaps. In calculating percent identity, typically only exact matches are counted.

4. DESCRIPTION OF THE FIGURES

Figures 1A-1B show the amino acid sequences of the (A) light chain variable region and (B) heavy chain variable region of a high affinity monoclonal antibody that binds to a RSV antigen the potency of which can be increased by methods described herein or in Applicants' copending applications Serial Nos. 60/168,426 and 60/186,252. For reference purposes, this is the amino acid sequence of the SYNAGIS® antibody disclosed in Johnson et al, 1997, J. Infect. Dis. 176:1215-1224 and U.S. Patent No. 5,824,307. Here, the CDR regions are underlined while non-underlined residues form the framework regions of the variable regions of each antibody. In this antibody, the CDRs are derived from a mouse antibody while the framework regions are derived from a human antibody. The constant regions (not shown) are also derived from a human antibody.

Figures 2A-2B show the (A) light chain variable region and (B) heavy light chain variable region for an antibody sequence. CDR regions are underlined. This sequence differs from the sequence disclosed in Figures 1A-1B in the first 4 residues of VH CDR1 of the light chain, residue 103 of the light chain and residue 112 of the heavy chain.

5. DETAILED DESCRIPTION OF THE INVENTION

The present invention provides methods of preventing, neutralizing, treating and ameliorating one or more symptoms associated with a RSV infection in a subject comprising administering to said subject one or more antibodies which immunospecifically bind to one or more RSV antigens with high affinity and/or high avidity and/or have a longer serum half-life. The high affinity and/or high avidity of the antibodies of the invention enable the use of lower doses of said antibodies than previously thought to be effective for the prevention, neutralization, treatment and the amelioration of symptoms associated with RSV infection. The use of lower doses of antibodies which immunospecifically bind to one or more RSV antigens reduces the likelihood of adverse effects, as well as providing a more effective prophylaxis. Further, the high affinity and/or high avidity of the antibodies of the invention enable less frequent administration of said

antibodies than previously thought to be necessary for the prevention, neutralization, treatment and the amelioration of symptoms associated with RSV infection.

The present invention also provides methods of preventing, neutralizing, treating and ameliorating one or more symptoms associated with a RSV infection in a subject comprising administering to said subject one or more antibodies which immunospecifically bind to one or more RSV antigens, said antibodies having a longer half-life than other previously known antibodies.

The present invention also provides improved methods of administering one or more antibodies which immunospecifically bind to one or more RSV antigens to a subject, said methods enable lower doses of said antibodies to be administered to the subject while achieving serum titers effective for the prevention, neutralization, treatment and amelioration of one or more symptoms associated with RSV infection. The present invention encompasses methods of delivering one or more antibodies which immunospecifically bind to one or more RSV antigens directly to the site of RSV infection. In particular, the invention encompasses pulmonary delivery of one or more antibodies which immunospecifically bind to one or more RSV antigens. The improved methods of delivering of one or more antibodies which immunospecifically bind to one or more RSV antigens reduces the dosage and frequency of administration of said antibodies to a subject.

The present invention is based, in part, upon achieving or inducing a serum titer of 1 μg/ml or less, preferably 2 μg/ml or less, 5 μg/ml or less, 6 μg/ml or less, 10 μg/ml or less, 15 μg/ml or less, 20 μg/ml or less, or 25 μg/ml or less of an antibody or fragment thereof that immunospecifically binds to a respiratory syncytial virus (RSV) antigen in a mammal with higher affinity and/or higher avidity than previously known antibodies, while reducing or avoiding adverse affects. Preferably a serum titer or serum titer of 1 μg/ml or less, preferably 2 μg/ml or less, 5 μg/ml or less, 6 μg/ml or less, 10 μg/ml or less, 15 μg/ml or less, 20 μg/ml or less, or 25 μg/ml or less is achieved approximately 20 days (preferably 25, 30, 35 or 40 days) after administration of a first dose of antibodies or fragments thereof which immunospecifically bind to a RSV antigen and without administration of any other doses of said antibodies or fragments thereof.

The present invention provides methods of achieving or inducing a serum titer of at least 30 μg/ml, at least 40 μg/ml, at least 50 μg/ml, at least 75 μg/ml, at least 100 μg/ml, at least 125 μg/ml, at least 150 μg/ml, at least 175 μg/ml, at least 200 μg/ml, at least 225 μg/ml, at least 250 μg/ml, at least 275 μg/ml, at least 300 μg/ml, at least 325 μg/ml, at least 350 μg/ml, at least 375 μg/ml, or at least 400 μg/ml of an antibody or fragment thereof that immunospecifically binds to a respiratory syncytial virus (RSV) antigen in a mammal, while reducing or avoiding adverse affects. Preferably a serum titer or serum titer of at least

30 μg/ml, preferably at least 40 μg/ml, at least 50 μg/ml, at least 75 μg/ml, at least 100 μg/ml, at least 125 μg/ml, at least 150 μg/ml, at least 175 μg/ml, at least 200 μg/ml, at least 225 μg/ml, at least 250 μg/ml, at least 275 μg/ml, at least 300 μg/ml, at least 325 μg/ml, at least 350 μg/ml, at least 375 μg/ml, or at least 400 μg/ml is achieved approximately 30 days after administration of a first dose of antibodies or fragments thereof which immunospecifically bind to a RSV antigen and without administration of any other doses of said antibodies or fragments thereof.

In a specific embodiment, a serum titer in a non-primate mammal of at least 40 μg/ml, preferably at least 80 μg/ml, at least 100 μg/ml, at least 120 μg/ml, at least 150 μg/ml, at least 200 μg/ml, at least 250 μg/ml, or at least 300 μg/ml, of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens is achieved at least 1 day after administering a dose of less than 2.5 mg/kg, preferably less than 1 mg/kg, or less than 0.5 mg/kg of the antibodies or antibody fragments to the non-primate mammal. In another embodiment, a serum titer in a non-primate mammal of at least 150 μg/ml, preferably at least 200 μg/ml, at least 250 μg/ml, at least 300 μg/ml, at least 350 μg/ml, or at least 400 μg/ml of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens is achieved at least 1 day after administering a dose of approximately 5 mg/kg of the antibodies or antibody fragments to the non-primate mammal.

In another embodiment, a serum titer in a primate of at least 40 μg/ml, preferably at least 80 μg/ml, at least 100 μg/ml, at least 120 μg/ml, at least 150 μg/ml, at least 200 μg/ml, at least 250 μg/ml, or at least 300 μg/ml of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens is achieved at least 30 days after administering a first dose of less than 5 mg/kg, preferably less than 3 mg/kg, less than 1 mg/kg, or less than 0.5 mg/kg of the antibodies or fragments thereof to the primate. In yet another embodiment, a serum titer in a primate of at least 200 μg/ml, at least 250 μg/ml, at least 300 μg/ml, at least 350 μg/ml, or at least 400 μg/ml of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens is achieved at least 30 days after administering a first dose of approximately 15 mg/kg of the antibodies or fragments thereof to the primate. In accordance with these embodiments, the primate is preferably a human.

The present invention provides methods for preventing, treating, or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, said methods comprising administering a first dose to said mammal of a prophylactically or therapeutically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, wherein said effective amount is

less than 15 mg/kg of said antibodies or fragments thereof and which results in a serum titer of greater than 40 μg/ml 30 days after the first administration and prior to any subsequent administration. In one embodiment, RSV infection in a human subject is prevented or treated, or one or more symptoms associated with RSV infection is ameliorated by administering a first dose of less than 10 mg/kg, preferably less than 5 mg/kg, less than 3 mg/kg, or less than 1 mg/kg of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens so that a serum antibody titer of at least 40 μg/ml, preferably at least 80 μg/ml, or at least 120 μg/ml, at least 150 μg/ml, at least 200 μg/ml, at least 250 μg/ml, or at least 300 μg/ml is achieved 30 days after the administration of the first dose of the antibodies or antibody fragments and prior to the administration of a subsequent dose. In another embodiment, RSV infection in a human subject is prevented or treated, or one or more symptoms associated with a RSV infection is ameliorated by administering a first dose of approximately 15 mg/kg of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens so that a serum antibody titer of at least 75 μg/ml, preferably at least 100 μg/ml, at least 200 μg/ml, at least 250 μg/ml, at least 300 μg/ml, at least 350 μg/ml, or at least 400 μg/ml is achieved 30 days after the administration of the first dose of the antibodies or antibody fragments and prior to the administration of a subsequent dose. In yet another embodiment, RSV infection in a human subject is prevented or treated, or one or more symptoms associated with a RSV infection is ameliorated by administering a first dose of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens such that a prophylactically or therapeutically effective serum titer of less than 10 μg/ml, preferably less than 5 μg/ml, less than 3 μg/ml, less than 1 μg/ml, or less than 0.5 μg/ml is achieved no more than 30 days after administering the antibodies or antibody fragments. In accordance with this embodiment, the first dose of one or more antibodies or fragments thereof is less than 10 mg/kg, preferably less than 5 mg/kg, less than 1 mg/kg, or less than 0.5 mg/kg.

The present invention provides antibodies or fragments thereof which immunospecifically bind to a RSV antigen with an affinity constant of at least 2×10^8 M^{-1}, at least 2.5×10^8 M^{-1}, at least 5×10^8 M^{-1}, at least 10^9 M^{-1}, at least 5×10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5×10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5×10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5×10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5×10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5×10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5×10^{15} M^{-1}. Preferably, the antibodies or antibody fragments have a higher affinity for a RSV antigen than SYNAGIS® does for the RSV F glycoprotein. The present invention also provides pharmaceutical compositions comprising one or more antibodies which immunospecifically bind to a RSV antigen with an affinity constant of at

least 2 X 10^8 M^{-1}, at least 2.5 X 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1}.

The present invention also provides antibodies or fragments thereof which immunospecifically bind to a RSV antigen with a higher avidity than any previously known antibodies or fragments thereof. Preferably, the antibodies or antibody fragments have higher avidity for a RSV antigen than SYNAGIS® has for the RSV F glycoprotein. The present invention also provides antibodies or fragments thereof that immunospecifically bind to a RSV antigen which have a higher affinity for a RSV antigen than any previously known antibodies or fragments thereof. The present invention also provides pharmaceutical compositions comprising one or more antibodies or fragments thereof which immunospecifically bind to a RSV antigen with a higher avidity than any previously known antibodies or fragments thereof.

The present invention also provides for antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with an affinity constant of at least 2 X 10^8 M^{-1}, at least 2.5 X 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1} and which have a higher avidity for one or more RSV antigens than any previously known antibodies or fragments thereof such as, *e.g.*, SYNAGIS®. The present invention further provides pharmaceutical compositions comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with an affinity constant of at least 2 X 10^8 M^{-1}, at least 2.5 X 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1} and which have a higher avidity for one or more RSV antigens than any previously known antibodies or fragments thereof such as, *e.g.*, SYNAGIS®.

The present invention provides methods of achieving a certain serum titer (preferably a serum titer 1 μg/ml or less, 2 μg/ml or less, 5 μg/ml or less, 6 μg/ml or less, 10 μg/ml or less, 15 μg/ml or less, 20 μg/ml or less, or 25 μg/ml or less) of antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens in a mammal, said methods comprising administering to said mammal one or more antibodies or fragments thereof that have an affinity constant of at least 2 X 10^8 M^{-1}, at least 2.5 X 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10}

M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1} for said RSV antigens. Preferably, the antibodies or antibody fragments have a higher affinity for a RSV antigen than SYNAGIS® does for the RSV F glycoprotein.

The present invention also provides methods of achieving a certain serum titer of antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens in a mammal, said methods comprising administering to said mammal one or more antibodies or fragments thereof that have a higher avidity for said RSV antigens than any previously known antibodies or antibody fragments. Preferably, the antibodies or antibody fragments have higher avidity for a RSV antigen than SYNAGIS® has for the RSV F glycoprotein.

The present invention also provides methods of achieving a certain serum titer of antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens in mammal, said methods comprising administering to said mammal one or more antibodies or fragments thereof that have an affinity constant of at least 2 X 10^8 M^{-1}, at least 2.5 X 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1} for one or more RSV antigens and have a higher avidity than any previously known antibodies or antibody fragments for said RSV antigens.

The present invention also provides methods of neutralizing RSV using antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens and which have an affinity constant of at least 2 X 10^8 M^{-1}, at least 2.5 X 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1} for said RSV antigens. Preferably, the antibodies or antibody fragments have a higher affinity for a RSV antigen than SYNAGIS® does for the RSV F glycoprotein. The present invention also provides methods of neutralizing RSV using antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens and which have a higher avidity for said RSV antigens than any previously known antibodies or antibody fragments. Preferably, the antibodies or antibody fragments have a higher avidity for a RSV antigen than SYNAGIS® does for the RSV F glycoprotein. The present invention also provides methods of neutralizing RSV using antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with an affinity constant of at least 2 X 10^8 M^{-1}, at least 2.5 X 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at

least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1} and which have a higher avidity for said RSV antigens than any previously known antibodies or antibody fragments. The higher affinity and/or higher avidity that these antibodies or antibody fragments have for a RSV antigen results in a lower concentration of these antibodies or antibody fragments necessary to achieve neutralization of RSV than previously known.

The present invention also provides methods for preventing, treating or ameliorating one or more symptoms of RSV infection in a mammal, said methods comprising administering to said mammal one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens and which have an affinity constant of at least 2 X 10^{8} M^{-1}, at least 2.5 X 10^{8} M^{-1}, at least 5 X 10^{8} M^{-1}, at least 10^{9} M^{-1}, at least 5 X 10^{9} M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1} for said RSV antigens. Preferably, the antibodies or antibody fragments have a higher affinity for a RSV antigen than SYNAGIS® does for the RSV F glycoprotein. The present invention also provides of methods preventing, treating or ameliorating one or more symptoms of RSV infection in a mammal, said methods comprising administering to said mammal one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigen and which have a higher avidity for said RSV antigen than any previously known antibodies or antibody fragments. Preferably, the antibodies or antibody fragments have a higher avidity for a RSV antigen than SYNAGIS® does for the RSV F glycoprotein. The present invention further provides methods of preventing, treating or ameliorating one or more symptoms of RSV infection in a mammal, said methods comprising administering to said mammal one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with an affinity constant of at least 2 X 10^{8} M^{-1}, at least 2.5 X 10^{8} M^{-1}, at least 5 X 10^{8} M^{-1}, at least 10^{9} M^{-1}, at least 5 X 10^{9} M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1} for said RSV antigen and which have a higher avidity for said RSV antigens than any previously known antibodies or antibody fragments. The higher affinity and/or higher avidity that these antibodies or antibody fragments have for a RSV antigen results in lower and/or less frequent doses of these antibodies or antibody fragments to achieve a prophylactic or therapeutic effect in a mammal, preferably a human, than previously known.

The present invention provides methods for preventing, treating, or ameliorating one or more symptoms associated with a RSV infection in a mammal, preferably a human, said methods comprising administering a first dose to said mammal of a prophylactically or therapeutically effective amount of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with a higher avidity and/or affinity than previously known antibodies such as SYNAGIS®, wherein said effective amount is less than 15 mg/kg of said antibodies or fragments thereof and which results in a serum titer less than 30 μg/ml (which is preferably at least 2 μg/ml, more preferably at least 4 μg/ml, and most preferably at least 6 μg/ml) 30 days after the first administration and prior to any subsequent administration. In one embodiment, RSV infection in a human subject is prevented or treated, or one or more symptoms in a human subject is ameliorated by administering a first dose of less than 10 mg/kg, preferably less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg, or less than 0.5 mg/kg of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with a higher avidity and/or affinity than previously known antibodies such as SYNAGIS® so that a serum antibody titer of at least 6 μg/ml, preferably at least 10 μg/ml, at least 25 μg/ml, at least 30 μg/ml, at least 40 μg/ml at least 80 μg/ml, or at least 120 μg/ml, at least 150 μg/ml, at least 200 μg/ml, at least 250 μg/ml, or at least 300 μg/ml is achieved 30 days after the administration of the first dose of the antibodies or antibody fragments and prior to the administration of a subsequent dose.

The present invention provides antibodies or fragments thereof comprising a variable heavy ("VH") domain having an amino acid sequence of any VH domain listed in Table 2, and pharmaceutical compositions comprising said antibodies or antibody fragments. The present invention also provides antibodies or fragments thereof comprising one or more VH CDRs having the amino acid sequence of one or more VH CDRs listed in Table 2 and/or Table 3, and pharmaceutical compositions comprising said antibodies or antibody fragments. The present invention also provides antibodies or fragments thereof comprising a variable light ("VL") domain having the amino acid sequence of any VL domain listed in Table 2, and pharmaceutical compositions comprising said antibodies or antibody fragments. The present invention also provides antibodies or fragments thereof comprising one or more VL CDRs having the amino acid sequence of one or more VL CDRs listed in Table 2 and/or Table 3, and pharmaceutical compositions comprising said antibodies or antibody fragments. The present invention also provides antibodies or fragments thereof comprising a VH domain having the amino acid sequence any VH domain listed in Table 2 and a VL domain having the amino acid sequence of any VL domain listed in Table 2, and pharmaceutical compositions comprising said antibodies or

antibody fragments. The present invention provides antibodies or fragments thereof comprising one or more VH CDRs having the amino acid sequence one or more VH CDRs listed in Table 2 and/or Table 3 and one or more VL CDRs having the amino acid sequence of one or more VL CDRs listed in Table 2 and/or Table 3. The present invention encompasses pharmaceutical compositions comprising said antibodies or antibody fragments. Preferably, said antibodies or antibody fragments immunospecifically bind to one or more RSV antigens.

The present invention encompasses methods for preventing, treating, neutralizing and ameliorating one or more symptoms using one or more antibodies comprising a variable heavy ("VH") domain having an amino acid sequence of any VH domain listed in Table 2. The present invention also encompasses methods for preventing, treating, neutralizing and ameliorating one or more symptoms using one or more antibodies comprising one or more VH CDRs having the amino acid sequence of one or more VH CDRs listed in Table 2 and/or Table 3. The present invention also encompasses methods for preventing, treating, neutralizing and ameliorating one or more symptoms using one or more antibodies comprising a variable light ("VL") domain having the amino acid sequence of any VL domain listed in Table 2. The present invention also encompasses methods for preventing, treating, neutralizing and ameliorating one or more symptoms using one or more antibodies comprising one or more VL CDRs having the amino acid sequence of one or more VL CDRs listed in Table 2 and/or Table 3. The present invention also encompasses methods for preventing, treating, neutralizing and ameliorating one or more symptoms using one or more antibodies comprising a VH domain having the amino acid sequence any VH domain listed in Table 2 and a VL domain having the amino acid sequence of any VL domain listed in Table 2. The present invention further encompasses methods for preventing, treating, neutralizing and ameliorating one or more symptoms using one or more antibodies comprising one or more VH CDRs having the amino acid sequence one or more VH CDRs listed in Table 2 and/or Table 3 and one or more VL CDRs having the amino acid sequence of one or more VL CDRs listed in Table 2 and/or Table 3. Preferably, said antibodies or antibody fragments immunospecifically bind to one or more RSV antigens.

The present invention encompasses antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with increased *in vivo* half-lives. In particular, the present invention encompasses HL-SYNAGIS and antigen-binding fragments thereof. The present invention also encompasses novel antibodies or fragments thereof described herein which immunospecifically bind to one or more RSV antigens and have an Fc domain with a higher affinity for the FcRn receptor than the Fc domain of SYNAGIS®.

The present invention also encompasses methods for the prevention, neutralization, treatment or amelioration of one or more symptoms associated with a RSV infection using antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with increased *in vivo* half-lives. In particular, the invention encompasses methods for the prevention, neutralization, treatment or amelioration of one or more symptoms associated with a RSV infection using HL-SYNAGIS or an antigen-binding fragment thereof The invention also encompasses methods for the prevention, neutralization, treatment or amelioration of one or more symptoms associated with a RSV infection using novel antibodies or fragments thereof described herein which immunospecifically bind to one or more RSV antigens and have an Fc domain with a higher affinity for the FcRn receptor than the Fc domain of SYNAGIS®.

The present invention provides sustained release formulations of antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens for the prevention, neutralization, treatment or amelioration of one or more symptoms associated with a RSV infection. In particular, the present invention provides sustained release formulations of SYNAGIS® or fragments thereof for the prevention, neutralization, treatment or amelioration of one or more symptoms associated with a RSV infection. The present invention also provides sustained release formulations of one or more novel antibodies or fragments thereof described herein which immunospecifically bind to one or more RSV antigens for the prevention, neutralization, treatment or amelioration of one or more symptoms associated with a RSV infection.

The present invention also provides methods of administering compositions comprising antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens to the site of a RSV infection in a subject. In particular, the present invention provides compositions comprising one or more antibodies or fragments thereof for pulmonary delivery to a subject.

The present invention provides compositions comprising one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, and methods for detecting or diagnosing a RSV infection utilizing said antibodies or antibody fragments.

5.1. Antibodies

It should be recognized that antibodies that immunospecifically bind to a RSV antigen are known in the art. For example, SYNAGIS® is a humanized monoclonal antibody presently used for the prevention of RSV infection in pediatric patients. The present invention encompasses novel formulations for administration of SYNAGIS® and

other known anti-RSV antibodies and novel doses of SYNAGIS® and other known anti-RSV antibodies, as discussed herein.

In addition, the invention encompasses novel antibodies, fragments and other biological or macromolecules which immunospecifically bind to one or more RSV antigens. With respect to these novel agents, the invention further encompasses novel modes of administration, doses, dosing and uses based, in part, upon their unique therapeutic profiles and potency.

Set forth below, is a more detailed description of the antibodies encompassed within the various aspects of the invention.

The present invention provides antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens. The present invention provides antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens. Preferably, the antibodies of the invention or fragments thereof immunospecifically bind to one or more RSV antigens regardless of the strain of RSV. The present invention also provides antibodies or fragments thereof that differentially or preferentially bind to RSV antigens from one strain of RSV versus another RSV strain. In a specific embodiment, the antibodies of the invention or fragments thereof immunospecifically bind to the RSV F glycoprotein, G glycoprotein or SH protein. In a preferred embodiment, the antibodies present invention or fragments thereof immunospecifically bind to the RSV F glycoprotein. In another preferred embodiment, the antibodies of the present invention or fragments thereof bind to the A, B, or C antigenic sites of the RSV F glycoprotein.

Antibodies of the invention include, but are not limited to, monoclonal antibodies, multispecific antibodies, human antibodies, humanized antibodies, chimeric antibodies, single-chain Fvs (scFv), single chain antibodies, Fab fragments, F(ab') fragments, disulfide-linked Fvs (sdFv), and anti-idiotypic (anti-Id) antibodies (including, *e.g.*, anti-Id antibodies to antibodies of the invention), and epitope-binding fragments of any of the above. In particular, antibodies of the present invention include immunoglobulin molecules and immunologically active portions of immunoglobulin molecules, *i.e.*, molecules that contain an antigen binding site that immunospecifically binds to a RSV antigen. The immunoglobulin molecules of the invention can be of any type (*e.g.*, IgG, IgE, IgM, IgD, IgA and IgY), class (*e.g.*, IgG_1, IgG_2, IgG_3, IgG_4, IgA_1 and IgA_2) or subclass of immunoglobulin molecule.

The antibodies of the invention may be from any animal origin including birds and mammals (*e.g.*, human, murine, donkey, sheep, rabbit, goat, guinea pig, camel, horse, or chicken). Preferably, the antibodies of the invention are human or humanized monoclonal antibodies. As used herein, "human" antibodies include antibodies having the amino acid

sequence of a human immunoglobulin and include antibodies isolated from human immunoglobulin libraries or from mice that express antibodies from human genes.

The antibodies of the present invention may be monospecific, bispecific, trispecific or of greater multispecificity. Multispecific antibodies may be specific for different epitopes of a RSV polypeptide or may be specific for both a RSV polypeptide as well as for a heterologous epitope, such as a heterologous polypeptide or solid support material. See, *e.g.*, PCT publications WO 93/17715, WO 92/08802, WO 91/00360, and WO 92/05793; Tutt, et al., J. Immunol. 147:60-69(1991); U.S. Patent Nos. 4,474,893, 4,714,681, 4,925,648, 5,573,920, and 5,601,819; and Kostelny et al., J. Immunol. 148:1547-1553 (1992).

The present invention provides for antibodies or fragments thereof that exhibit a high potency in an assay described herein. High potency antibodies or fragments thereof can be produced by methods disclosed in copending U.S. patent application Serial Nos. 60/168,426 and 60/186,252 and methods described herein. For example, high potency antibodies can be produced by genetically engineering appropriate antibody gene sequences and expressing the antibody sequences in a suitable host. The antibodies produced can be screened to identify antibodies with, *e.g.*, high k_{on} values in a BIAcore assay.

The present invention provides for antibodies or fragments thereof that have a high binding affinity for one or more RSV antigens. In a specific embodiment, an antibody of the present invention or fragment thereof has an association rate constant or k_{on} rate (antibody (Ab) + antigen $(Ag) \xrightarrow{k_{on}} Ab-Ag$) of at least $10^5\,M^{-1}s^{-1}$, at least $5 \times 10^5\,M^{-1}s^{-1}$, at least $10^6\,M^{-1}s^{-1}$, at least $5 \times 10^6\,M^{-1}s^{-1}$, at least $10^7\,M^{-1}s^{-1}$, at least $5 \times 10^7\,M^{-1}s^{-1}$, or at least $10^8\,M^{-1}s^{-1}$. In a preferred embodiment, an antibody of the present invention or fragment thereof has a k_{on} of at least $2 \times 10^5\,M^{-1}s^{-1}$, at least $5 \times 10^5\,M^{-1}s^{-1}$, at least $10^6\,M^{-1}s^{-1}$, at least $5 \times 10^6\,M^{-1}s^{-1}$, at least $10^7\,M^{-1}s^{-1}$, at least $5 \times 10^7\,M^{-1}s^{-1}$, or at least $10^8\,M^{-1}s^{-1}$.

In another embodiment, an antibody of the present invention or fragment thereof has a k_{off} rate (antibody (Ab) + antigen $(Ag) \xleftarrow{K_{off}} Ab-Ag$) of less than $10^{-1}\,s^{-1}$, less than $5 \times 10^{-1}\,s^{-1}$, less than $10^{-2}\,s^{-1}$, less than $5 \times 10^{-2}\,s^{-1}$, less than $10^{-3}\,s^{-1}$, less than $5 \times 10^{-3}\,s^{-1}$, less than $10^{-4}\,s^{-1}$, less than $5 \times 10^{-4}\,s^{-1}$, less than $10^{-5}\,s^{-1}$, less than $5 \times 10^{-5}\,s^{-1}$, less than $10^{-6}\,s^{-1}$, less than $5 \times 10^{-6}\,s^{-1}$, less than $10^{-7}\,s^{-1}$, less than $5 \times 10^{-7}\,s^{-1}$, less than $10^{-8}\,s^{-1}$, less than $5 \times 10^{-8}\,s^{-1}$, less than $10^{-9}\,s^{-1}$, less than $5 \times 10^{-9}\,s^{-1}$, or less than $10^{-10}\,s^{-1}$. In a preferred embodiment, an antibody of the present invention or fragment thereof has a k_{on} of less than $5 \times 10^{-4}\,s^{-1}$, less than $10^{-5}\,s^{-1}$, less than $5 \times 10^{-5}\,s^{-1}$, less than $10^{-6}\,s^{-1}$, less than $5 \times 10^{-6}\,s^{-1}$, less than $10^{-7}\,s^{-1}$, less than $5 \times 10^{-7}\,s^{-1}$, less than $10^{-8}\,s^{-1}$, less than $5 \times 10^{-8}\,s^{-1}$, less than $10^{-9}\,s^{-1}$, less than $5 \times 10^{-9}\,s^{-1}$, or less than $10^{-10}\,s^{-1}$.

In another embodiment, an antibody of the present invention or fragment thereof has an affinity constant or K_a (k_{on}/k_{off}) of at least 10^2 M^{-1}, at least 5 X 10^2 M^{-1}, at least 10^3 M^{-1}, at least 5 X 10^3 M^{-1}, at least 10^4 M^{-1}, at least 5 X 10^4 M^{-1}, at least 10^5 M^{-1}, at least 5 X 10^5 M^{-1}, at least 10^6 M^{-1}, at least 5 X 10^6 M^{-1}, at least 10^7 M^{-1}, at least 5 X 10^7 M^{-1}, at least 10^8 M^{-1}, at least 5 X 10^8 M^{-1}, at least 10^9 M^{-1}, at least 5 X 10^9 M^{-1}, at least 10^{10} M^{-1}, at least 5 X 10^{10} M^{-1}, at least 10^{11} M^{-1}, at least 5 X 10^{11} M^{-1}, at least 10^{12} M^{-1}, at least 5 X 10^{12} M^{-1}, at least 10^{13} M^{-1}, at least 5 X 10^{13} M^{-1}, at least 10^{14} M^{-1}, at least 5 X 10^{14} M^{-1}, at least 10^{15} M^{-1}, or at least 5 X 10^{15} M^{-1}. In yet another embodiment, an antibody or fragment thereof has a dissociation constant or K_d (k_{off}/k_{on}) of less than 10^{-2} M, less than 5 X 10^{-2} M, less than 10^{-3} M, less than 5 X 10^{-3} M, less than 10^{-4} M, less than 5 X 10^{-4} M, less than 10^{-5} M, less than 5 X 10^{-5} M, less than 10^{-6} M, less than 5 X 10^{-6} M, less than 10^{-7} M, less than 5 X 10^{-7} M, less than 10^{-8} M, less than 5 X 10^{-8} M, less than 10^{-9} M, less than 5 X 10^{-9} M, less than 10^{-10} M, less than 5 X 10^{-10} M, less than 10^{-11} M, less than 5 X 10^{-11} M, less than 10^{-12} M, less than 5 X 10^{-12} M, less than 10^{-13} M, less than 5 X 10^{-13} M, less than 10^{-14} M, less than 5 X 10^{-14} M, less than 10^{-15} M, or less than 5 X 10^{-15} M.

The present invention provides antibodies or fragment thereof that have a median effective concentration (EC_{50}) of less than 0.01 nM, less than 0.025 nM, less than 0.05 nM, less than 0.1 nM, less than 0.25 nM, less than 0.5 nM, less than 0.75 nM, less than 1 nM, less than 1.25 nM, less than 1.5 nM, less than 1.75 nM, or less than 2 nM, in an *in vitro* microneutralization assay. The median effective concentration is the concentration of antibody or antibody fragments that neutralizes 50% of the RSV in an *in vitro* microneutralization assay. In a preferred embodiment, antibody of the invention or fragment thereof has an EC_{50} of less than 0.01 nM, less than 0.025 nM, less than 0.05 nM, less than 0.1 nM, less than 0.25 nM, less than 0.5 nM, less than 0.75 nM, less than 1 nM, less than 1.25 nM, less than 1.5 nM, less than 1.75 nM, or less than 2 nM, in an *in vitro* microneutralization assay.

In a specific embodiment, an antibody of the present invention is SYNAGIS® or an antibody-binding fragment thereof (*e.g.*, one or more complementarity determining regions (CDRs) of SYNAGIS®). The amino acid sequence of SYNAGIS® is disclosed, *e.g.*, in Johnson et al., 1997, J. Infectious Disease 176:1215-1224, and U.S. Patent No. 5,824,307, and is also provided herein as SEQ ID NO:7. In alternative embodiment, an antibody of the present invention or fragment thereof is not SYNAGIS® or a fragment of SYNAGIS®.

The present invention provides for antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, said antibodies or antibody fragments comprising the amino acid sequence of SYNAGIS® with one or more amino acid residue substitutions in the variable light (VL) domain and/or variable heavy (VH)

domain depicted in Figure 1. The present invention also provides for antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, said antibodies or antibody fragments comprising the amino acid sequence of SYNAGIS® with one or more amino acid residue substitutions in one or more VL CDRs and/or one or more VH CDRs. In a specific embodiment, an antibody or fragment thereof comprises the amino acid sequence of SYNAGIS® with one or more amino acid residue substitutions of the amino acid residues indicated in bold face and underlining in Table 1. In accordance with this embodiment, the amino acid residue substitutions can be conservative or non-conservative. The antibody or antibody fragment generated by introducing substitutions in the VH domain, VH CDRs, VL domain and/or VL CDRs of SYNAGIS® can be tested *in vitro* and *in vivo,* for example, for its ability to bind to RSV F antigen, for its ability to neutralize RSV, or for its ability to prevent, treat or ameliorate one or more symptoms associated with a RSV infection.

Table 1. CDR Sequences Of SYNAGIS®

CDR	Sequence	SEQ ID NO:
VH1	T**S**GMSVG	1
VH2	DIWWD**D**K**KD**YNPSLK**S**	2
VH3	**S**MI**T**N**W**YFDV	3
VL1	**KCQLS**VGYMH	4
VL2	DT**SKLA**S	5
VL3	FQGS**G**YP**F**T	6

Bold faced & underlined amino acid residues are preferred residues which should be substituted.

In a specific embodiment, an antibody of the present invention comprises the amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92. Preferably, an antibody of the present invention comprises the amino acid sequence of SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92. In a preferred embodiment, an antibody of the present invention comprises a Fab fragment having the amino acid sequence of Fab fragment having the amino acid sequence of SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36, SEQ ID NO:39, SEQ ID NO:42, SEQ ID NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69, SEQ ID NO:73, SEQ ID NO: 137, SEQ ID NO:222, or SEQ ID NO:223.

In another embodiment, an antibody fragment of the present invention comprises the amino acid sequence of a portion of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92 that immunospecifically binds to a RSV antigen. In another embodiment, an antibody fragment of the present invention comprises a portion of a Fab fragment having the amino acid sequence of SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36, SEQ ID NO:39, SEQ ID NO:42, SEQ ID NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69, SEQ ID NO:73, SEQ ID NO:137, SEQ ID NO:222, or SEQ ID NO:223.

The present invention also provides antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, said antibodies or antibody fragments comprising a variable heavy ("VH") domain having an amino acid sequence of any one of the VH domains listed in Table 2. The present invention also provides antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, said antibodies or fragments comprising a VH complementarity determining region ("CDR") having an amino acid sequence of any one of the VH CDRs listed in Table 2 and/or Table 3.

Table 2. Antibodies & Fragments Thereof

MAb or Fabs	VH Domain	VH CDR1	VH CDR2	VH CDR3	VL Domain	VL CDR1	VL CDR2	VL CDR3
**SEQ ID NO:7	SEQ ID NO:8	TSGMSVG (SEQ ID NO:1)	DIWWDDKKDY NPSLKS (SEQ ID NO:2)	SMITNWYFDV (SEQ ID NO:3)	SEQ ID NO:9	KCQLSVGYMH (SEQ ID NO:4)	DTSKLAS (SEQ ID NO:5)	FQGSGYPFT (SEQ ID NO:6)
**SEQ ID NO:10	SEQ ID NO:11	TAGMSVG (SEQ ID NO:12	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	SMITNFYFDV (SEQ ID NO:13)	SEQ ID NO:14	SASSSVGYMH (SEQ ID NO:15)	DTFKLAS (SEQ ID NO:16)	FQGSFYPFT (SEQ ID NO:17)
**SEQ ID NO:78	SEQ ID NO:43	TPGMSVG (SEQ ID NO:44)	DIWWDDKKHYN PSLKD (SEQ ID NO:45)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:47	SLSSRVGYMH (SEQ ID NO:48)	DTFYLSS (SEQ ID NO:49)	FQGSGYPFT (SEQ ID NO:6)
**SEQ ID NO:79	SEQ ID NO:51	TPGMSVG (SEQ ID NO:44)	DIWWDGKKHYN PSLKD (SEQ ID NO:52)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:53	SLSSRVGYMH (SEQ ID NO:48)	DTRGLPS (SEQ ID NO:54)	FQGSGYPFT (SEQ ID NO:6)
**SEQ ID NO:80	SEQ ID NO:56	TPGMSVG (SEQ ID NO:44)	DIWWDGKKHYN PSLKD (SEQ ID NO:52)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:57	SPSSRVGYMH (SEQ ID NO:58)	DTMRLAS (SEQ ID NO:59)	FQGSGYPFT (SEQ ID NO:6)
**SEQ ID NO:81	SEQ ID NO:61	TAGMSVG (SEQ ID NO:12)	DIWWDGKKHYN PSLKD (SEQ ID NO:52)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:62	SLSSRVGYMH (SEQ ID NO:48)	DTFKLSS (SEQ ID NO:63)	FQGSGYPFT (SEQ ID NO:6)
**SEQ ID NO:82	SEQ ID NO:65	TAGMSVG (SEQ ID NO:12)	DIWWDGKKDYN PSLKD (SEQ ID NO:66)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:67	SASSRVGYMH (SEQ ID NO:38)	DTFKLSS (SEQ ID NO:68)	FQGSGYPFT (SEQ ID NO:6)
**SEQ ID NO:83	SEQ ID NO:74	TAGMSVG (SEQ ID NO:12)	DIWWDGKKSYN PSLKD (SEQ ID NO:75)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:76	SLSSRVGYMH (SEQ ID NO:48)	DTMYQSS (SEQ ID NO:77)	FQGSGYPFT (SEQ ID NO:6)

**SEQ ID NO:84	SEQ ID NO:85	TAGMSVG (SEQ ID NO:12)	DIWWDDKKSY NPSLKD (SEQ ID NO:96)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:87	LPSSRVGYMHW (SEQ ID NO:86)	DTMYQSS (SEQ ID NO:77)	FQGSGYPFT (SEQ ID NO:6)
**SEQ ID NO:88	SEQ ID NO:89	TAGMSVG (SEQ ID NO:12)	DIWWDDKKHY NPSLKD (SEQ ID NO:45)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:90	SASSRVGYMHW (SEQ ID NO:38)	DTLLLDS (SEQ ID NO:91)	FQGSGYPFT (SEQ ID NO:6)
**SEQ ID NO:92	SEQ ID NO:93	TAGMSVG (SEQ ID NO:12)	DIWWDDKKSY NPSLKD (SEQ ID NO:96)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:94	SPSSRVGYMHW (SEQ ID NO:58)	DTRYQSS (SEQ ID NO:95)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:18	SEQ ID NO:11	TSGMSVG (SEQ ID NO:1)	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	SMITNWYFDV (SEQ ID NO:3)	SEQ ID NO:19	SASSSVGYMH (SEQ ID NO:15)	DTSKLAS (SEQ ID NO:5)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:20	SEQ ID NO:21	TAGMSVG (SEQ ID NO:12)	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:23	SASSSVGYMH (SEQ ID NO:15)	DTFKLAS (SEQ ID NO:16)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:24	SEQ ID NO:21	TAGMSVG (SEQ ID NO:12)	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:25	SASSSVGYMH (SEQ ID NO:15)	DTYKQTS (SEQ ID NO:26)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:27	SEQ ID NO:21	TAGMSVG (SEQ ID NO:12)	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:28	SASSSVGYMH (SEQ ID NO:15	DTRYLSS (SEQ ID NO:29)	FQGSGYPFT (SEQ ID NO:6
*SEQ ID NO:30	SEQ ID NO:31	TAGMSVG (SEQ ID NO:12)	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	DMITNFYFDV (SEQ ID NO:32)	SEQ ID NO:23	SASSSVGYMH (SEQ ID NO:15)	DTFKLAS (SEQ ID NO:16)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:33	SEQ ID NO:11	TAGMSVG (SEQ ID NO:12)	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	SMITNFYFDV (SEQ ID NO:13)	SEQ ID NO:14	SASSSVGYMH (SEQ ID NO:15)	DTFKLAS (SEQ ID NO:16)	FQGSFYPFT (SEQ ID NO:17)

*SEQ ID NO:34	SEQ ID NO:31	TAGMSVG (SEQ ID NO:12)	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	DMITNFYFDV (SEQ ID NO:32)	SEQ ID NO:35	SASSSVGYMH (SEQ ID NO:15)	DTFKLTS (SEQ ID NO:103)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:36	SEQ ID NO:31	TAGMSVG (SEQ ID NO:12)	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	DMITNFYFDV (SEQ ID NO:32)	SEQ ID NO:37	SASSRVGYMH (SEQ ID NO:38)	DTFKLAS (SEQ ID NO:16)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:39	SEQ ID NO:31	TAGMSVG (SEQ ID NO:12)	DIWWDDKKDYN PSLKS (SEQ ID NO:2)	DMITNFYFDV (SEQ ID NO:22)	SEQ ID NO:40	SASSSVGYMH (SEQ ID NO:15)	DTFRLAS (SEQ ID NO:41)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:42	SEQ ID NO:43	TPGMSVG (SEQ ID NO:44)	DIWWDDKKHYN PSLKD (SEQ ID NO:45)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:47	SLSSRVGYMH (SEQ ID NO:48)	DTFYLSS (SEQ ID NO:49)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:50	SEQ ID NO:51	TPGMSVG (SEQ ID NO:44)	DIWWDGKKHYN PSLKD (SEQ ID NO:52)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:53	SLSSRVGYMH (SEQ ID NO:48)	DTRGLPS (SEQ ID NO:54)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:55	SEQ ID NO:56	TPGMSVG (SEQ ID NO:44)	DIWWDGKKHYN PSLKD (SEQ ID NO:52)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:57	SPSSRVGYMH (SEQ ID NO:58)	DTMRLAS (SEQ ID NO:59)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:60	SEQ ID NO:61	TAGMSVG (SEQ ID NO:12)	DIWWDGKKHYN PSLKD (SEQ ID NO:52)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:62	SLSSRVGYMH (SEQ ID NO:48)	DTFKLSS (SEQ ID NO:63)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:64	SEQ ID NO:65	TAGMSVG (SEQ ID NO:12)	DIWWDGKKDYN PSLKD (SEQ ID NO:66)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:67	SASSRVGYMH (SEQ ID NO:38)	DTFKLSS (SEQ ID NO:68)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:69	SEQ ID NO:70	TAGMSVG (SEQ ID NO:12)	DIWWDDKKHYN PSLKD (SEQ ID NO:52)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:71	SPSSRVGYMH (SEQ ID NO:58)	DTYRHSS (SEQ ID NO:72)	FQGSGYPFT (SEQ ID NO:6)

*SEQ ID NO:222	SEQ ID NO:85	TAGMSVG (SEQ ID NO:12)	DIWWDDKKSY NPSLKD (SEQ ID NO:96)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:87	LPSSRVGYMHW (SEQ ID NO:86)	DTMYQSS (SEQ ID NO:77)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:223	SEQ ID NO:93	TAGMSVG (SEQ ID NO:12)	DIWWDDKKSY NPSLKD (SEQ ID NO:96)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:94	SPSSRVGYMHW (SEQ ID NO:58)	DTRYQSS (SEQ ID NO:95)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:225	SEQ ID NO:61	TAGMSVG (SEQ ID NO:12)	DIWWDGKKHYN PSLKD (SEQ ID NO:52)	DMIFNWYFDV (SEQ ID NO:32)	SEQ ID NO:226	SLSSSVGYMH (SEQ ID NO:128)	DTFFHRS (SEQ ID NO:227)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:137	SEQ ID NO:89	TAGMSVG (SEQ ID NO:12)	DIWWDDKKHY NPSLKD (SEQ ID NO:45)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:90	SASSRVGYMHW (SEQ ID NO:38)	DTLLLDS (SEQ ID NO:91)	FQGSGYPFT (SEQ ID NO:6)
*SEQ ID NO:73	SEQ ID NO:74	TAGMSVG (SEQ ID NO:12)	DIWWDDKKSYN PSLKD (SEQ ID NO:96)	DMIFNFYFDV (SEQ ID NO:46)	SEQ ID NO:76	SLSSRVGYMH (SEQ ID NO:48)	DTMYQSS (SEQ ID NO:77)	FQGSGYPFT (SEQ ID NO:6)

Bold faced & underlined amino acid residues are the residues which differ from the amino acid residues in SYNAGIS™; Fab fragment (*); Monoclonal antibody (**)

Table 3. CDR Sequences

VH CDR1	VH CDR2	VH CDR3	VL CDR1	VL CDR2	VL CDR3
TSGMSVG (SEQ ID NO:1)	DIWWDDKKDYNPSLKS (SEQ ID NO:2)	SMITNWYFDV (SEQ ID NO:3)	KCQLSVGYMH (SEQ ID NO:4)	DTSKLAS (SEQ ID NO:5)	FQGSGYPFT (SEQ ID NO:6)
TPGMSVG (SEQ ID NO:44)	DIWWDDKKHYNPSLKD (SEQ ID NO:45)	DMITNFYFDV (SEQ ID NO:22)	KCQSSVGYMH (SEQ ID NO:113)	DTSYLAS (SEQ ID NO:68)	
TAGMSVG (SEQ ID NO:12)	DIWWDDKKHYNPSLKS (SEQ ID NO:102)	DMITNWYFDV (SEQ ID NO:109)	KCQSRVGYMH (SEQ ID NO:114)	DTSYLSS (SEQ ID NO:188)	
	DIWWDDKKDYNPSLKD (SEQ ID NO:97)	DMIFNWYFDV (SEQ ID NO:32)	KCQLRVGYMH (SEQ ID NO:115)	DTKKLSS (SEQ ID NO:189)	
	DIWWDDKKHYNPSLKD (SEQ ID NO:98)	DMIFNFYFDV (SEQ ID N0:46)	KLQLSVGYMH (SEQ ID NO:116)	DTFYLSS (SEQ ID NO:49)	
	DIWWDDKKHYNPSLKS (SEQ ID NO:99)	SMITNFYFDV (SEQ ID NO:13)	KLQSSVGYMH (SEQ ID NO:117)	DTFKLAS (SEQ ID NO:16)	
	DIWWDDKKDYNPSLKD (SEQ ID NO:100)	SMIFNWYFDV (SEQ ID NO:111)	KLQSRVGYMH (SEQ ID NO:118)	DTFKLSS (SEQ ID NO:63)	
	DIWWDGKKHYNPSLKD (SEQ ID NO:52)	SMIFNFYFDV (SEQ ID NO:112)	KLQLRVGYMH (SEQ ID NO:119)	DTFYLAS (SEQ ID NO:191)	
	DIWWDGKKDYNPSLKS (SEQ ID NO:101)		KLSLSVGYMH (SEQ ID NO:120)	DTSKLPS (SEQ ID NO:192)	
	DIWWDGKKDYNPSLKD (SEQ ID NO:66)		KLSSSVGYMH (SEQ ID NO:121)	DTSGLAS (SEQ ID NO:193)	
	DIWWDGKKHYNPSLKS (SEQ ID NO:105)		KLSSRVGYMH (SEQ ID NO:122)	DTSGLPS (SEQ ID NO:194)	

	DIWWD**D**KK**S**YNPSLK**S** (SEQ ID NO:104)		**KLSLR**VGYMH (SEQ ID NO:123)	DT**RG**L**P**S (SEQ ID NO:54)	
	DIWWD**D**KK**S**YNPSLK**D** (SEQ ID NO:96)		**KCSLS**VGYMH (SEQ ID NO:124)	DT**RK**L**A**S (SEQ ID NO:195)	
	DIWWD**G**KK**S**YNPSLK**S** (SEQ ID NO:106)		**KCSSS**VGYMH (SEQ ID NO:125)	DT**RG**L**A**S (SEQ ID NO:196)	
	DIWWD**G**KK**S**YNPSLK**D** (SEQ ID NO:75)		**KCSSR**VGYMH (SEQ ID NO:126)	DT**RK**L**P**S (SEQ ID NO:224)	
			KCSLRVGYMH (SEQ ID NO:126)	DT**MR**L**A**S (SEQ ID NO:59)	
			SLSLSVGYMH (SEQ ID NO:127)	DT**MK**L**A**S (SEQ ID NO:197)	
			SLSSSVGYMH (SEQ ID NO:128)	DT**SR**L**A**S (SEQ ID NO:198)	
			SLSSRVGYMH (SEQ ID NO:48)	DT**SL**L**A**S (SEQ ID NO:199)	
			SLSLRVGYMH (SEQ ID NO:129)	DT**SL**L**D**S (SEQ ID NO:200)	
			SCQLSVGYMH (SEQ ID NO:130)	DT**SK**L**D**S (SEQ ID NO:201)	
			SCQSSVGYMH (SEQ ID NO:131)	DT**LL**L**D**S (SEQ ID NO:91)	
			SCQSRVGYMH (SEQ ID NO:132)	DT**LK**L**D**S (SEQ ID NO:202)	

			SCQLRVGYMH (SEQ ID NO:133)	DTLLLAS (SEQ ID NO:203)	
			SLQLSVGYMH (SEQ ID NO:134)	DT**LKLA**S (SEQ ID NO:204)	
			SLQSSVGYMH (SEQ ID NO:135)	DT**SKLS**S (SEQ ID NO:205)	
			SLQSRVGYMH (SEQ ID NO:136)	DT**SKQA**S (SEQ ID NO:206)	
			SLQLRVGYMH (SEQ ID NO:138)	DT**SKQS**S (SEQ ID NO:207)	
			SCSLSVGYMH (SEQ ID NO:139)	DT**SYLA**S (SEQ ID NO:208)	
			SCSSSVGYMH (SEQ ID NO:140)	DT**SYLS**S (SEQ ID NO:209)	
			SCSSRVGYMH (SEQ ID NO:141)	DT**SYQA**S (SEQ ID NO:210)	
			SCSLRVGYMH (SEQ ID NO:142)	DT**SYQS**S (SEQ ID NO:211)	
			KPSSRVGYMH (SEQ ID NO:143)	DT**MYQA**S (SEQ ID NO:212)	
			KPSLRVGYMH (SEQ ID NO:144)	DT**MYQS**S (SEQ ID NO:77)	
			KPSSSVGYMH (SEQ ID NO:145)	DT**MKQA**S (SEQ ID NO:213)	

			KPSLSVGYMH (SEQ ID NO:146)	DT**MKQS**S (SEQ ID NO:214)	
			KPQSRVGYMH (SEQ ID NO:147)	DT**MYLA**S (SEQ ID NO:215)	
			KPQLRVGYMH (SEQ ID NO:148)	DT**MYLS**S (SEQ ID NO:216)	
			KPQSSVGYMH (SEQ ID NO:149)	DT**MKLA**S (SEQ ID NO:217)	
			KPQLSVGYMH (SEQ ID NO:150)	DT**MKLS**S (SEQ ID NO:218)	
			SPSSRVGYMH (SEQ ID NO:151)	DT**SKLS**S (SEQ ID NO:219)	
			SPSLRVGYMH (SEQ ID NO:152)	DT**RYQA**S (SEQ ID NO:220)	
			SPSSSVGYMH (SEQ ID NO:153)	DT**RYQS**S (SEQ ID NO:95)	
			SPSLSVGYMH (SEQ ID NO:154)	DT**RKQA**S (SEQ ID NO:221)	
			SPQSRVGYMH (SEQ ID NO:155)	DT**RKQS**S (SEQ ID NO:190)	
			SPQLRVGYMH (SEQ ID NO:156)	DT**RKLA**S (SEQ ID NO:107)	
			SPQSSVGYMH (SEQ ID NO:157)	DT**RKLS**S (SEQ ID NO:108)	

			SPQLSVGYMH (SEQ ID NO:158)	DT**RYLA**S (SEQ ID NO:110)	
			KAQSRVGYMH (SEQ ID NO:159)	DT**RYLS**S (SEQ ID NO:29)	
			KAQLRVGYMH (SEQ ID NO:160)		
			KAQSSVGYMH (SEQ ID NO:161)		
			KAQLSVGYMH (SEQ ID NO:162)		
			KASSRVGYMH (SEQ ID NO:163)		
			KASLRVGYMH (SEQ ID NO:164)		
			KASSSVGYMH (SEQ ID NO:165)		
			KASLSVGYMH (SEQ ID NO:166)		
			SASSRVGYMH (SEQ ID NO:38)		
			SASLRVGYMH (SEQ ID NO:167)		
			SASSSVGYMH (SEQ ID NO:15)		

			SASLSVGYMH (SEQ ID NO:168)		
			SAQSRVGYMH (SEQ ID NO:169)		
			SAQLRVGYMH (SEQ ID NO:170)		
			SAQSSVGYMH (SEQ ID NO:171)		
			LPSSRVGYMH (SEQ ID NO:86)		
			LPSLSVGYMH (SEQ ID NO:172)		
			LPSSSVGYMH (SEQ ID NO:173)		
			LPSLRVGYMH (SEQ ID NO:174)		
			LCSSRVGYMH (SEQ ID NO:175)		
			LCSLSVGYMH (SEQ ID NO:176)		
			LCSSSVGYMH (SEQ ID NO:177)		
			LCSLRVGYMH (SEQ ID NO:178)		

			LPQSRVGYMH (SEQ ID NO:179)		
			LPQLSVGYMH (SEQ ID NO:180)		
			LPQSSVGYMH (SEQ ID NO:181)		
			LPQLRVGYMH (SEQ ID NO:182)		
			LCQSRVGYMH (SEQ ID NO:183)		
			LCQLSVGYMH (SEQ ID NO:184)		
			LCQSSVGYMH (SEQ ID NO:185)		
			LCQLRVGYMH (SEQ ID NO:186)		
			SAQLSVGYMH (SEQ ID NO:187)		

In one embodiment of the present invention, antibodies or fragments thereof comprise a VH CDR1 having the amino acid sequence of SEQ ID NO:1, SEQ ID NO:12 or SEQ ID NO:44. In another embodiment, antibodies or fragments thereof comprise a VH CDR2 having the amino acid sequence of SEQ ID NO:2, SEQ ID NO:45, SEQ ID NO:52, SEQ ID NO:66, SEQ ID NO:75 or SEQ ID NO:96. In another embodiment, antibodies comprise a VH CDR3 having the amino acid sequence of SEQ ID NO:3, SEQ ID NO:13, SEQ ID NO:22, SEQ ID NO:32 or SEQ ID NO:46. In a preferred embodiment, antibodies or fragments thereof comprise a VH CDR1 having the amino acid sequence of SEQ ID NO:1, SEQ ID NO:12 or SEQ ID NO:44, a VH CDR2 having the amino acid sequence of SEQ ID NO:2, SEQ ID NO:45, SEQ ID NO:52, SEQ ID NO:66, SEQ ID NO:75 or SEQ ID NO:96, and a VH CDR3 having the amino acid sequence of SEQ ID NO:3, SEQ ID NO:13, SEQ ID NO:22, SEQ ID NO:32 or SEQ ID NO:46.

The present invention also provides antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, said antibodies or antibody fragments comprising a variable light ("VL") domain having an amino acid sequence of any one of the VL domains listed in Table 2. The present invention also provides antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, said antibodies or fragments comprising a VL CDR having an amino acid sequence of any one of the VL CDRs listed in Table 2 and/or Table 3.

In one embodiment of the present invention, antibodies or fragments thereof comprise a VL CDR1 having the amino acid sequence of SEQ ID NO:4, SEQ ID NO:15, SEQ ID NO:38, SEQ ID NO:48, SEQ ID NO:58 or SEQ ID NO:86. In another embodiment, antibodies or fragments thereof comprise a VL CDR2 having the amino acid sequence of SEQ ID NO:5, SEQ ID NO:16, SEQ ID NO:26, SEQ ID NO:29,, SEQ ID NO:41, SEQ ID NO:49, SEQ ID NO:54, SEQ ID NO:59, SEQ ID NO:63, SEQ ID NO:72, SEQ ID NO:77, SEQ ID NO:91, SEQ ID NO:95 or SEQ ID NO:103. In another embodiment, antibodies or fragments thereof comprise a VL CDR3 having the amino acid sequence of SEQ ID NO:6 or SEQ ID NO:17. In a preferred embodiment, antibodies or fragments thereof comprise a VL CDR1 having the amino acid sequence of SEQ ID NO:4, SEQ ID NO:15, SEQ ID NO:38, SEQ ID NO:48, SEQ ID NO:58 or SEQ ID NO:86, a VL CDR2 having the amino acid sequence of SEQ ID NO:5, SEQ ID NO:16, SEQ ID NO:26, SEQ ID NO:29, SEQ ID NO:41, SEQ ID NO:49, SEQ ID NO:54, SEQ ID NO:59, SEQ ID NO:63, SEQ ID NO:72, SEQ ID NO:77, SEQ ID NO:91, SEQ ID NO:95, or SEQ ID NO:103, and a VL CDR3 having the amino acid sequence of SEQ ID NO:6 or SEQ ID NO:17.

The present invention also provides antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, said antibodies or antibody fragments comprising a VH domain disclosed herein combined with a VL domain disclosed herein, or other VL domain. The present invention further provides antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, said antibodies or fragments comprising a VL domain disclosed herein combined with a VH domain disclosed herein, or other VH domain. In a preferred embodiment, antibodies or fragments thereof that immunospecifically bind to a RSV antigen comprise a VH domain having the amino acid sequence of SEQ ID NO:8, SEQ ID NO:11, SEQ ID NO:21, SEQ ID NO:31, SEQ ID NO:43, SEQ ID NO:51, SEQ ID NO:56, SEQ ID NO:61, SEQ ID NO:65, SEQ ID NO:70, SEQ ID NO:74, SEQ ID NO:85, SEQ ID NO:89 or SEQ ID NO:93 and a VL domain having the amino acid sequence of SEQ ID NO:9, SEQ ID NO:14, SEQ ID NO:19, SEQ ID NO:23, SEQ ID NO:25, SEQ ID NO:28, SEQ ID NO:35, SEQ ID NO:37, SEQ ID NO:40, SEQ ID NO:47, SEQ ID NO:53, SEQ ID NO:57, SEQ ID NO:62, SEQ ID NO:67, SEQ ID NO:71, SEQ ID NO:76, SEQ ID NO:87, SEQ ID NO:90 or SEQ ID NO:94.

The present invention also provides antibodies or fragments thereof comprising one or more VH CDRs and one or more VL CDRs listed in Table 2 and/or Table 3. In particular, the invention provides for an antibody or fragment thereof comprising a VH CDR1 and a VL CDR1, a VH CDR1 and a VL CDR2, a VH CDR1 and a VL CDR3, a VH CDR2 and a VL CDR1, VH CDR2 and VL CDR2, a VH CDR2 and a VL CDR3, a VH CDR3 and a VH CDR1, a VH CDR3 and a VL CDR2, a VH CDR3 and a VL CDR3, or any combination thereof of the VH CDRs and VL CDRs listed in Table 2. The invention also provides for an antibody or fragment thereof comprising a VH CDR1 and a VL CDR1, a VH CDR1 and a VL CDR2, a VH CDR1 and a VL CDR3, a VH CDR2 and a VL CDR1, VH CDR2 and VL CDR2, a VH CDR2 and a VL CDR3, a VH CDR3 and a VH CDR1, a VH CDR3 and a VL CDR2, a VH CDR3 and a VL CDR3, or any combination thereof of the VH CDRs and VL CDRs listed in Table 3. The invention also provides for an antibody or fragment thereof comprising a VH CDR1 and a VL CDR1, a VH CDR1 and a VL CDR2, a VH CDR1 and a VL CDR3, a VH CDR2 and a VL CDR1, VH CDR2 and VL CDR2, a VH CDR2 and a VL CDR3, a VH CDR3 and a VH CDR1, a VH CDR3 and a VL CDR2, a VH CDR3 and a VL CDR3, or any combination thereof of the VH CDRs and VL CDRs listed in Table 2 and Table 3.

In one embodiment, an antibody or fragment thereof comprises a VH CDR1 having the amino acid sequence of SEQ ID NO:1, SEQ ID NO:12 or SEQ ID NO:44 and a VL CDR1 having the amino acid sequence of SEQ ID NO:4, SEQ ID NO:15, SEQ ID NO:38, SEQ ID NO:48, SEQ ID NO:58 or SEQ ID NO:86. In another embodiment, an antibody of

the present invention or fragment thereof comprises a VH CDR1 having the amino acid sequence of SEQ ID NO:1, SEQ ID NO:12 or SEQ ID NO:44 and a VL CDR2 having the amino acid sequence of SEQ ID NO:5, SEQ ID NO:16, SEQ ID NO:26, SEQ ID NO:29, SEQ ID NO:41, SEQ ID NO:49, SEQ ID NO:54, SEQ ID NO:59, SEQ ID NO:63, SEQ ID NO:72, SEQ ID NO:77, SEQ ID NO:91, SEQ ID NO:95, or SEQ ID NO:103. In another embodiment, an antibody of the present invention or fragment thereof comprises a VH CDR1 having the amino acid sequence of SEQ ID NO:1, SEQ ID NO:12 or SEQ ID NO:44 and a VL CDR3 having the amino acid sequence of SEQ ID NO:6 or SEQ ID NO:17.

In another embodiment, an antibody of the present invention or fragment thereof comprises a VH CDR2 having the amino acid sequence of SEQ ID NO:2, SEQ ID NO:45, SEQ ID NO:52, SEQ ID NO:66, SEQ ID NO:75 or SEQ ID NO:96 and a VL CDR1 having the amino acid sequence of SEQ ID NO:4, SEQ ID NO:15, SEQ ID NO:38, SEQ ID NO:48, SEQ ID NO:58 or SEQ ID NO:86. In another embodiment, an antibody of the present invention or fragment thereof comprises a VH CDR2 having the amino acid sequence of SEQ ID NO:2, SEQ ID NO:45, SEQ ID NO:52, SEQ ID NO:66, SEQ ID NO:75 or SEQ ID NO:96 and a VL CDR2 having the amino acid sequence of SEQ ID NO:5, SEQ ID NO:16, SEQ ID NO:26, SEQ ID NO:29, SEQ ID NO:41, SEQ ID NO:49, SEQ ID NO:54, SEQ ID NO:59, SEQ ID NO:63, SEQ ID NO:72, SEQ ID NO:77, SEQ ID NO:91, SEQ ID NO:95, or SEQ ID NO:103. In another embodiment, an antibody of the present invention or fragment thereof comprises a VH CDR2 having the amino acid sequence of SEQ ID NO:2, SEQ ID NO:45, SEQ ID NO:52, SEQ ID NO:66, SEQ ID NO:75 or SEQ ID NO:96 and a VL CDR3 having the amino acid sequence of SEQ ID NO:6 or SEQ ID NO:17.

In another embodiment, an antibody of the present invention or fragment thereof comprises a VH CDR3 having the amino acid sequence of SEQ ID NO:3, SEQ ID NO:13, SEQ ID NO:22, SEQ ID NO:32 or SEQ ID NO:46 and a VL CDR1 having the amino acid sequence of SEQ ID NO:4, SEQ ID NO:15, SEQ ID NO:38, SEQ ID NO:48, SEQ ID NO:58 or SEQ ID NO:86. In another embodiment, an antibody of the present invention or fragment thereof comprises a VH CDR3 having the amino acid sequence of SEQ ID NO:3, SEQ ID NO:13, SEQ ID NO:22, SEQ ID NO:32 or SEQ ID NO:46 and a VL CDR2 having the amino acid sequence of SEQ ID NO:5, SEQ ID NO:16, SEQ ID NO:26, SEQ ID NO:29, SEQ ID NO:41, SEQ ID NO:49, SEQ ID NO:54, SEQ ID NO:59, SEQ ID NO:63, SEQ ID NO:72, SEQ ID NO:77, SEQ ID NO:91, SEQ ID NO:95 or SEQ ID NO:103. In a preferred embodiment, an antibody of the present invention or fragment thereof comprises a VH CDR3 having the amino acid sequence of SEQ ID NO:3, SEQ ID NO:13, SEQ ID

NO:22, SEQ ID NO:32 or SEQ ID NO:46 and a VL CDR3 having the amino acid sequence of SEQ ID NO:6 or SEQ ID NO:17.

The present invention also provides for a nucleic acid molecule, generally isolated, encoding an antibody of the invention or fragment thereof. In a specific embodiment, an isolated nucleic acid molecule of the invention encodes an antibody having the amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92. Preferably, an isolated nucleic acid molecule of the invention encodes an antibody having the amino acid sequence of SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92. In another embodiment, an isolated nucleic acid molecule of the invention encodes an antibody comprising a Fab fragment having the amino acid sequence of SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36 SEQ ID NO:39, SEQ ID NO:42, SEQ ID NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69, SEQ ID NO:73, SEQ ID NO:137, SEQ ID NO:222, or SEQ ID NO:223.

In another embodiment, an isolated nucleic acid molecule of the invention encodes an antibody fragment having the amino acid sequence of portion of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92 that immunospecifically binds to a RSV antigen. In another embodiment, an isolated nucleic acid molecule of the invention encodes an antibody fragment having the amino acid sequence of SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36 SEQ ID NO:39, SEQ ID NO:42, SEQ ID NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69, SEQ ID NO:73, SEQ ID NO:137, SEQ ID NO:222, or SEQ ID NO:223.

In another embodiment, an isolated nucleic acid molecule of the invention encodes an antibody or fragment thereof comprising a VH domain having an amino acid sequence of any one of the VH domains listed in Table 2. In another embodiment, an isolated nucleic acid molecule of the invention encodes an antibody or fragment thereof comprising a VH CDR1 having an amino acid sequence of any one of the VH CDR1s listed in Table 2 or Table 3. In another embodiment, an isolated nucleic acid molecule of the invention encodes an antibody or fragment thereof comprising a VH CDR2 having an amino acid sequence of any one of the VH CDR2s listed in Table 2 or Table 3. In yet another embodiment, an isolated nucleic acid molecule of the invention encodes an antibody or fragment thereof

comprising a VH CDR3 having an amino acid sequence of any one of the VH CDR3s listed in Table 2 or Table 3.

In another embodiment, an isolated nucleic acid molecule of the invention encodes an antibody or fragment thereof comprising a VL domain having an amino acid sequence of any one of the VL domains listed in Table 2. In another embodiment, an isolated nucleic acid molecule of the present invention encodes an antibody or fragment thereof comprising a VL CDR1 having amino acid sequence of any one of the VL CDR1s listed in Table 2 or Table 3. In another embodiment, an isolated nucleic acid molecule of the present invention encodes an antibody or fragment thereof comprising a VL CDR2 having an amino acid sequence of any one of the VL CDR2s listed in Table 2 or Table 3. In yet another embodiment, an isolated nucleic acid molecule of the present invention encodes an antibody or fragment thereof comprising a VL CDR3 having an amino acid sequence of any one of the VL CDR3s listed in Table 2 or Table 3.

In another embodiment, a nucleic acid molecule of the invention encodes an antibody or fragment thereof comprising a VH domain having an amino acid sequence of any one of the VH domains listed in Table 2 and a VL domain having an amino acid sequence of any one of the VL domains listed in Table 2. In another embodiment, a nucleic acid molecule of the invention encodes an antibody or fragment thereof comprising a VH CDR1, a VL CDR1, a VH CDR2, a VL CDR2, a VH CDR3, a VL CDR3, or any combination thereof having an amino acid sequence listed in Table 2. In another embodiment, a nucleic acid molecule of the invention encodes an antibody or fragment thereof comprising a VH CDR1, a VL CDR1, a VH CDR2, a VL CDR2, a VH CDR3, a VL CDR3, or any combination thereof having an amino acid sequence listed in Table 3. In another embodiment, a nucleic acid molecule of the invention encodes an antibody or fragment thereof comprising a VH CDR1, a VL CDR1, a VH CDR2, a VL CDR2, a VH CDR3, a VL CDR3, or any combination thereof having an amino acid sequence listed in Table 2 and Table 3.

The present invention also provides antibodies or fragments thereof comprising derivatives of the VH domains, VH CDRs, VL domains, and VL CDRs described herein that immunospecifically bind to an RSV antigen. The present invention also provides antibodies or fragments thereof comprising derivatives of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92. The present invention further provides antibodies or fragments thereof comprising derivatives of Fab fragments having the amino acid sequence of SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36 SEQ ID NO:39,

SEQ ID NO:42, SEQ ID NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69, SEQ ID NO:73, SEQ ID NO:137, SEQ ID NO:222, or SEQ ID NO:223. Standard techniques known to those of skill in the art can be used to introduce mutations in the nucleotide sequence encoding a molecule of the invention, including, for example, site-directed mutagenesis and PCR-mediated mutagenesis which results in amino acid substitutions. Preferably, the derivatives include less than 25 amino acid substitutions, less than 20 amino acid substitutions, less than 15 amino acid substitutions, less than 10 amino acid substitutions, less than 5 amino acid substitutions, less than 4 amino acid substitutions, less than 3 amino acid substitutions, or less than 2 amino acid substitutions relative to the original molecule. In a preferred embodiment, the derivatives have conservative amino acid substitutions are made at one or more predicted non-essential amino acid residues. A "conservative amino acid substitution" is one in which the amino acid residue is replaced with an amino acid residue having a side chain with a similar charge. Families of amino acid residues having side chains with similar charges have been defined in the art. These families include amino acids with basic side chains (*e.g.*, lysine, arginine, histidine), acidic side chains (*e.g.*, aspartic acid, glutamic acid), uncharged polar side chains (*e.g.*, glycine, asparagine, glutamine, serine, threonine, tyrosine, cysteine), nonpolar side chains (*e.g.*, alanine, valine, leucine, isoleucine, proline, phenylalanine, methionine, tryptophan), beta-branched side chains (*e.g.*, threonine, valine, isoleucine) and aromatic side chains (*e.g.*, tyrosine, phenylalanine, tryptophan, histidine). Alternatively, mutations can be introduced randomly along all or part of the coding sequence, such as by saturation mutagenesis, and the resultant mutants can be screened for biological activity to identify mutants that retain activity. Following mutagenesis, the encoded protein can be expressed and the activity of the protein can be determined.

In a specific embodiment, an antibody or fragment thereof that immunospecifically binds to a RSV antigen comprises a nucleotide sequence that hybridizes to the nucleotide sequence encoding SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36, SEQ ID NO:39, SEQ ID NO:42, SEQ ID NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69, SEQ ID NO:73, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88, SEQ ID NO:92, SEQ ID NO:137, SEQ ID NO:222, or SEQ ID NO:223 under stringent conditions, *e.g.*, hybridization to filter-bound DNA in 6x sodium chloride/sodium citrate (SSC) at about 45 °C followed by one or more washes in 0.2xSSC/0.1% SDS at about 50-65 ° C, under highly stringent conditions, *e.g.*, hybridization to filter-bound nucleic acid in 6xSSC at about 45 °C followed by one or more washes in 0.1xSSC/0.2% SDS at about

68 °C, or under other stringent hybridization conditions which are known to those of skill in the art (see, for example, Ausubel, F.M. et al., eds. , 1989, *Current Protocols in Molecular Biology*, Vol. I, Green Publishing Associates, Inc. and John Wiley & Sons, Inc., New York at pages 6.3.1-6.3.6 and 2.10.3).

In another embodiment, an antibody or fragment thereof that immunospecifically binds to a RSV antigen comprises an amino acid sequence that is at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% identical to the amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36 SEQ ID NO:39, SEQ ID NO:42, SEQ ID NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69, SEQ ID NO:73, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88, SEQ ID NO:92, SEQ ID NO:137, SEQ ID NO:222, or SEQ ID NO:223.

In a specific embodiment, an antibody or fragment thereof that immunospecifically binds to a RSV antigen comprises an amino acid sequence of a VH domain or an amino acid sequence a VL domain encoded by a nucleotide sequence that hybridizes to the nucleotide sequence encoding any one of the VH or VL domains listed in Table 2 under stringent conditions, *e.g.*, hybridization to filter-bound DNA in 6x sodium chloride/sodium citrate (SSC) at about 45 °C followed by one or more washes in 0.2xSSC/0.1% SDS at about 50-65 ° C, under highly stringent conditions, *e.g.*, hybridization to filter-bound nucleic acid in 6xSSC at about 45 °C followed by one or more washes in 0.1xSSC/0.2% SDS at about 68 °C, or under other stringent hybridization conditions which are known to those of skill in the art (see, for example, Ausubel, F.M. et al., eds. , 1989, *Current Protocols in Molecular Biology*, Vol. I, Green Publishing Associates, Inc. and John Wiley & Sons, Inc., New York at pages 6.3.1-6.3.6 and 2.10.3). In another embodiment, an antibody or fragment thereof that immunospecifically binds to a RSV antigen comprises an amino acid sequence of a VH CDR or an amino acid sequence of a VL CDRs encoded by a nucleotide sequence that hybridizes to the nucleotide sequence encoding any one of the VH CDRs or VL CDRs listed in Table 2 or Table 3 under stringent conditions *e.g.*, hybridization to filter-bound DNA in 6x sodium chloride/sodium citrate (SSC) at about 45 °C followed by one or more washes in 0.2xSSC/0.1% SDS at about 50-65 ° C, under highly stringent conditions, *e.g.*, hybridization to filter-bound nucleic acid in 6xSSC at about 45 °C followed by one or more washes in 0.1xSSC/0.2% SDS at about 68 °C, or under other stringent hybridization conditions which are known to those of skill in the art. In yet another embodiment, an antibody or fragment thereof that immunospecifically binds

to a RSV antigen comprises an amino acid sequence of a VH CDR and an amino acid sequence of a VL CDR encoded by nucleotide sequences that hybridizes to the nucleotide sequences encoding any one of the VH CDRs and VL CDRs, respectively, listed in Table 2 or Table 3 under stringent conditions, *e.g.*, hybridization to filter-bound DNA in 6x sodium chloride/sodium citrate (SSC) at about 45 °C followed by one or more washes in 0.2xSSC/0.1% SDS at about 50-65 ° C, under highly stringent conditions, *e.g.*, hybridization to filter-bound nucleic acid in 6xSSC at about 45 °C followed by one or more washes in 0.1xSSC/0.2% SDS at about 68 °C, or under other stringent hybridization conditions which are known to those of skill in the art .

In another embodiment, an antibody or fragment thereof that immunospecifically binds to a RSV antigen comprises an amino acid sequence of a VH domain that is at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% identical to any one of the VH domains listed in Table 2. In another embodiment, an antibody or fragment thereof that immunospecifically binds to a RSV antigen comprises an amino acid sequence of one or more VH CDRs that are at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% identical to any of the VH CDRs listed in Table 2 or Table 3.

In another embodiment, an antibody or fragment thereof that immunospecifically binds to a RSV antigen comprises an amino acid sequence of a VL domain that is at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% identical to any one of the VL domains listed in Table 2. In another embodiment, an antibody or fragment thereof that immunospecifically binds to a RSV antigen comprises an amino acid sequence of one or more VL CDRs that are at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 95%, or at least 99% identical to any of the VL CDRs listed in Table 2 or Table 3.

The present invention also encompasses antibodies or fragments thereof that compete with an antibody or Fab fragment listed in Table 2 for binding to a RSV antigen. In particular, the present invention encompasses antibodies or fragments thereof that compete with SYNAGIS® or an antigen-binding fragment thereof for binding to the RSV F glycoprotein. The present invention also encompasses VL domains, VH domains, VL CDRs, and VH CDRs that compete with a VL domain, VH domain, VL CDR, or VH CDR listed in Table 2 for binding to a RSV antigen. Further, the present invention encompasses

VL CDRs and VL CDRs that compete with a VL CDR or VH CDR listed in Table 3 for binding to a RSV antigen.

The antibodies of the invention include derivatives that are modified, *i.e*, by the covalent attachment of any type of molecule to the antibody such that covalent attachment. For example, but not by way of limitation, the antibody derivatives include antibodies that have been modified, *e.g.*, by glycosylation, acetylation, pegylation, phosphorylation, amidation, derivatization by known protecting/blocking groups, proteolytic cleavage, linkage to a cellular ligand or other protein, etc. Any of numerous chemical modifications may be carried out by known techniques, including, but not limited to specific chemical cleavage, acetylation, formylation, metabolic synthesis of tunicamycin, etc. Additionally, the derivative may contain one or more non-classical amino acids.

The present invention also provides antibodies of the invention or fragments thereof that comprise a framework region known to those of skill in the art. Preferably, the fragment region of an antibody of the invention or fragment thereof is human. In a specific embodiment, an antibody of the invention or fragment thereof comprises the framework region of SYNAGIS®.

The present invention also provides for antibodies or fragments thereof that have half-lives in a mammal, preferably a human, of greater than 15 days, preferably greater than 20 days, greater than 25 days, greater than 30 days, greater than 35 days, greater than 40 days, greater than 45 days, greater than 2 months, greater than 3 months, greater than 4 months, or greater than 5 months. The increased half-lives of the antibodies of the present invention or fragments thereof in a mammal, preferably a human, results in a higher serum titer of said antibodies or antibody fragments in the mammal, and thus, reduces the frequency of the administration of said antibodies or antibody fragments and/or reduces the concentration of said antibodies or antibody fragments to be administered. Antibodies or fragments thereof having increased *in vivo* half-lives can be generated by techniques known to those of skill in the art. For example, antibodies or fragments thereof with increased *in vivo* half-lives can be generated by modifying (*e.g.*, substituting, deleting or adding) amino acid residues identified as involved in the interaction between the Fc domain and the FcRn receptor (see, *e.g.*, PCT Publication No. WO 97/34631, which is incorporated herein by reference in its entirety). Such antibodies or fragments thereof can be tested for binding activity to RSV antigens as well as for *in vivo* efficacy using methods known to those skilled in the art, for example, by immunoassays described herein.

Further, antibodies or fragments thereof with increased *in vivo* half-lives can be generated by attaching to said antibodies or antibody fragments polymer molecules such as high molecular weight polyethyleneglycol (PEG). PEG can be attached to said antibodies

or antibody fragments with or without a multifunctional linker either through site-specific conjugation of the PEG to the N– or C- terminus of said antibodies or antibody fragments or via epsilon-amino groups present on lysine residues. Linear or branched polymer derivatization that results in minimal loss of biological activity will be used. The degree of conjugation will be closely monitored by SDS-PAGE and mass spectrometry to ensure proper conjugation of PEG molecules to the antibodies. Unreacted PEG can be separated from antibody-PEG conjugates by, *e.g.*, size exclusion or ion-exchange chromatography. PEG-derivatizated antibodies or fragments thereof can be tested for binding activity to RSV antigens as well as for *in vivo* efficacy using methods known to those skilled in the art, for example, by immunoassays described herein.

The present invention also encompasses antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens, said antibodies or antibody fragments comprising the amino acid sequence of SYNAGIS® with mutations (*e.g.*, one or more amino acid substitutions) in the framework regions. In certain embodiments, antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens comprise the amino acid sequence of SYNAGIS® with one or more amino acid residue substitutions in the framework regions of the VH and/or VL domains depicted in Figure 1. In a specific embodiment, antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens comprise the framework regions depicted in Figure 2.

The present invention also encompasses antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens, said antibodies or fragments thereof comprising the amino acid sequence of SYNAGIS® with mutations (*e.g.*, one or more amino acid residue substitutions) in the variable and framework regions.

The present invention also provides for fusion proteins comprising an antibody or fragment thereof that immunospecifically binds to a RSV antigen and a heterologous polypeptide. Preferably, the heterologous polypeptide that the antibody or antibody fragment is fused to is useful for targeting the antibody to respiratory epithelial cells.

The present invention also provides for panels of antibodies or fragments thereof that immunospecifically bind to an RSV antigen. In specific embodiments, the invention provides for panels of antibodies or fragments thereof having different affinities for an RSV antigen, different specificities for an RSV antigen, or different dissociation rates. The invention provides panels of at least 10, preferably at least 25, at least 50, at least 75, at least 100, at least 125, at least 150, at least 175, at least 200, at least 250, at least 300, at least 350, at least 400, at least 450, at least 500, at least 550, at least 600, at least 650, at least 700, at least 750, at least 800, at least 850, at least 900, at least 950, or at least 1000

antibodies or fragments thereof. Panels of antibodies can be used, for example, in 96 well plates for assays such as ELISAs.

The present invention further provides for compositions comprising one or more antibodies of the invention or fragments thereof. In a specific embodiment, a composition of the present invention comprises one or more antibodies having an amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising a Fab fragment having an amino acid sequence of SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36 SEQ ID NO:39, SEQ ID NO:42, SEQ ID NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69, SEQ ID NO:73, SEQ ID NO:137, SEQ ID NO:222, or SEQ ID NO:223.

In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH domains having an amino acid sequence of any one of the VH domains listed in Table 2. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR1s having an amino acid sequence of any one of the VH CDR1s listed in Table 2 or Table 3. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR2s having an amino acid sequence of any one of the VH CDR2s listed in Table 2 or Table 3. In a preferred embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR3s having an amino acid sequence of any one of the VH CDR3s listed in Table 2 or Table 3.

In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VL domains having an amino acid sequence of any one of the VL domains listed in Table 2. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VL CDR1s having an amino acid sequence of any one of the VH CDR1s listed in Table 2 or Table 3. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VL CDR2s having an amino acid sequence of any one of the VL CDR2s listed in Table 2 or Table 3. In a preferred embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VL CDR3s having an amino acid sequence of any one of the VL CDR3s listed in Table 2 or Table 3.

In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH domains having an amino acid sequence of any one of the VH domains listed in Table 2 and one or more VL domains having an amino acid sequence of any one of the VL domains listed in Table 2. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR1s having an amino acid sequence of any one of the VH CDR1s listed in Table 2 or Table 3 and one or more VL CDR1s having an amino acid sequence of any one of the VL CDR1s listed in Table 2 or Table 3. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR1s having an amino acid sequence of any one of the VH CDR1s listed in Table 2 or Table 3 and one or more VL CDR2s having an amino acid sequence of any one of the VL CDR2s listed in Table 2 or Table 3. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR1s having an amino acid sequence of any one of the VH CDR1s listed in Table 2 or Table 3 and one or more VL CDR3s having an amino acid sequence of any one of the VL CDR3s listed in Table 2 or Table 3.

In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR2s having an amino acid sequence of any one of the VH CDR2s listed in Table 2 or Table 3 and one or more VL CDR1s having an amino acid sequence of any one of the VL CDR1s listed in Table 2 or Table 3. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR2s having an amino acid sequence of any one of the VH CDR2s listed in Table 2 or Table 3 and one or more VL CDR2s having an amino acid sequence of any one of the VL CDR2s listed in Table 2 or Table 3. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR2s having an amino acid sequence of any one of the VH CDR2s listed in Table 2 or Table 3 and one or more VL CDR3s having an amino acid sequence of any one of the VL CDR3s listed in Table 2 or Table 3.

In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR3s having an amino acid sequence of any one of the VH CDR3s listed in Table 2 or Table 3 and one or more VL CDR1s having an amino acid sequence of any one of the VL CDR1s listed in Table 2 or Table 3. In another embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR3s having an amino

acid sequence of any one of the VH CDR3s listed in Table 2 or Table 3 and one or more VL CDR2s having an amino acid sequence of any one of the VL CDR2s listed in Table 2 or Table 3. In a preferred embodiment, a composition of the present invention comprises one or more antibodies or fragments thereof comprising one or more VH CDR3s having an amino acid sequence of any one of the VH CDR3s listed in Table 2 or Table 3 and one or more VL CDR3s having an amino acid sequence of any one of the VL CDR3s listed in Table 2 or Table 3. In yet another embodiment, a composition of the present invention comprises one or more fusion proteins of the invention.

As discussed in more detail below, a composition of the invention may be used either alone or in combination with other compositions. The antibodies or fragments thereof may further be recombinantly fused to a heterologous polypeptide at the N – or C-terminus or chemically conjugated (including covalently and non-covalently conjugations) to polypeptides or other compositions. For example, antibodies of the present invention may be recombinantly fused or conjugated to molecules useful as labels in detection assays and effector molecules such as heterologous polypeptides, drugs, radionuclides, or toxins. See, *e.g.*, PCT publications WO 92/08495; WO 91/14438; WO 89/12624; U.S. Patent No. 5,314,995; and EP 396,387.

Antibodies of the present invention or fragments thereof may be used, for example, to purify, detect, and target RSV antigens, in both *in vitro* and *in vivo* diagnostic and therapeutic methods. For example, the antibodies or fragments have use in immunoassays for qualitatively and quantitatively measuring levels of the RSV in biological samples such as sputum. See, *e.g.*, Harlow *et al.*, Antibodies: A Laboratory Manual, (Cold Spring Harbor Laboratory Press, 2nd ed. 1988) (incorporated by reference herein in its entirety).

5.1.1. Antibody Conjugates

The present invention encompasses antibodies or fragments thereof recombinantly fused or chemically conjugated (including both covalently and non-covalently conjugations) to a heterologous polypeptide (or portion thereof, preferably at least 10, at least 20, at least 30, at least 40, at least 50, at least 60, at least 70, at least 80, at least 90 or at least 100 amino acids of the polypeptide) to generate fusion proteins. The fusion does not necessarily need to be direct, but may occur through linker sequences. For example, antibodies may be used to target heterologous polypeptides to particular cell types (*e.g.*, respiratory epithelial cells), either *in vitro* or *in vivo*, by fusing or conjugating the antibodies to antibodies specific for particular cell surface receptors. Antibodies fused or conjugated to heterologous polypeptides may also be used in *in vitro* immunoassays and purification methods using methods known in the art. See *e.g.*, PCT publication WO 93/21232; EP 439,095; Naramura

et al., Immunol. Lett. 39:91-99 (1994); U.S. Patent 5,474,981; Gillies et al., PNAS 89:1428-1432 (1992); and Fell et al., J. Immunol. 146:2446-2452(1991), which are incorporated by reference in their entireties.

In one embodiment, a fusion protein of the invention comprises an antibody having the amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92 and a heterologous polypeptide. In another embodiment, a fusion protein of the invention comprises an antibody or antibody fragment having the amino acid sequence of SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36 SEQ ID NO:39, SEQ ID NO:42, SEQ ID NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69, SEQ ID NO:73, SEQ ID NO:137, SEQ ID NO:222, or SEQ ID NO:223 and a heterologous polypeptide. In another embodiment, a fusion protein of the invention comprises one or more VH domains having the amino acid sequence of any one of the VH domains listed in Table 2 or one or more VL domains having the amino acid sequence of any one of the VL domains listed in Table 2 and a heterologous polypeptide. In another embodiment, a fusion protein of the present invention comprises one or more VH CDRs having the amino acid sequence of any one of the VH CDRs listed in Table 2 or Table 3 and a heterologous polypeptide. In another embodiment, a fusion protein comprises one or more VL CDRs having the amino acid sequence of any one of the VL CDRs listed in Table 2 or Table 3 and a heterologous polypeptide. In another embodiment, a fusion protein of the invention comprises at least one VH domain and at least one VL domain listed in Table 2 and a heterologous polypeptide. In yet another embodiment, a fusion protein of the invention comprises at least one VH CDR and at least one VL CDR domain listed in Table 2 or Table 3 and a heterologous polypeptide.

The present invention further includes compositions comprising heterologous polypeptides fused or conjugated to antibody fragments. For example, the heterologous polypeptides may be fused or conjugated to a Fab fragment, Fd fragment, Fv fragment, $F(ab)_2$ fragment, or portion thereof. Methods for fusing or conjugating polypeptides to antibody portions are known in the art. See, *e.g.*, U.S. Patent Nos. 5,336,603, 5,622,929, 5,359,046, 5,349,053, 5,447,851, and 5,112,946; EP 307,434; EP 367,166; PCT publication Nos. WO 96/04388 and WO 91/06570; Ashkenazi et al., Proc. NatI. Acad. Sci. USA 88: 10535-10539 (1991); Zheng et al., J. Immunol. 154:5590-5600 (1995); and Vil et al., Proc. Natl. Acad. Sci. USA 89:11337- 11341(1992) (said references incorporated by reference in their entireties).

Additional fusion proteins of the invention may be generated through the techniques of gene-shuffling, motif-shuffling, exon-shuffling, and/or codon-shuffling (collectively referred to as "DNA shuffling"). DNA shuffling may be employed to alter the activities of antibodies of the invention or fragments thereof (*e.g.*, antibodies or fragments thereof with higher affinities and lower dissociation rates). See, generally, U.S. Patent Nos. 5,605,793; 5,811,238; 5,830,721; 5,834,252; and 5,837,458, and Patten et al., Curr. Opinion Biotechnol. 8:724-33 (1997); Harayama, Trends Biotechnol. 16(2):76-82 (1998); Hansson, et al., J. Mol. Biol. 287:265-76 (1999); and Lorenzo and Blasco, Biotechniques 24(2):308-13 (1998) (each of these patents and publications are hereby incorporated by reference in its entirety). In one embodiment, antibodies or fragments thereof, or the encoded antibodies or fragments thereof, may be altered by being subjected to random mutagenesis by error-prone PCR, random nucleotide insertion or other methods prior to recombination. In another embodiment, one or more portions of a polynucleotide encoding an antibody or antibody fragment, which portions immunospecifically bind to a RSV antigen may be recombined with one or more components, motifs, sections, parts, domains, fragments, etc. of one or more heterologous molecules.

Moreover, the antibodies of the present invention or fragments thereof can be fused to marker sequences, such as a peptide to facilitate purification. In preferred embodiments, the marker amino acid sequence is a hexa-histidine peptide, such as the tag provided in a pQE vector (QIAGEN, Inc., 9259 Eton Avenue, Chatsworth, CA, 91311), among others, many of which are commercially available. As described in Gentz et al., 1989, Proc. Natl. Acad. Sci. USA 86:821-824, for instance, hexa-histidine provides for convenient purification of the fusion protein. Other peptide tags useful for purification include, but are not limited to, the hemagglutinin"HA" tag, which corresponds to an epitope derived from the influenza hemagglutinin protein (Wilson et al., 1984, Cell 37:767) and the "flag" tag.

The present invention further encompasses antibodies or fragments thereof conjugated to a diagnostic or therapeutic agent. The antibodies can be used diagnostically to, for example, monitor the development or progression of a RSV infection as part of a clinical testing procedure to, *e.g.*, determine the efficacy of a given treatment regimen. Detection can be facilitated by coupling the antibody or fragment thereof to a detectable substance. Examples of detectable substances include various enzymes, prosthetic groups, fluorescent materials, luminescent materials, bioluminescent materials, radioactive materials, positron emitting metals, and nonradioactive paramagnetic metal ions. The detectable substance may be coupled or conjugated either directly to the antibody (or fragment thereof) or indirectly, through an intermediate (such as, for example, a linker known in the art) using techniques known in the art. See, for example, U.S. Patent No.

4,741,900 for metal ions which can be conjugated to antibodies for use as diagnostics according to the present invention. Examples of suitable enzymes include horseradish peroxidase, alkaline phosphatase, beta-galactosidase, or acetylcholinesterase; examples of suitable prosthetic group complexes include streptavidin/biotin and avidin/biotin; examples of suitable fluorescent materials include umbelliferone, fluorescein, fluorescein isothiocyanate, rhodamine, dichlorotriazinylamine fluorescein, dansyl chloride or phycoerythrin; an example of a luminescent material includes luminol; examples of bioluminescent materials include luciferase, luciferin, and aequorin; and examples of suitable radioactive material include ^{125}I, ^{131}I, ^{111}In or ^{99}Tc.

An antibody or fragment thereof may be conjugated to a therapeutic moiety such as a cytotoxin, *e.g.*, a cytostatic or cytocidal agent, a therapeutic agent or a radioactive metal ion, *e.g.*, alpha-emitters. A cytotoxin or cytotoxic agent includes any agent that is detrimental to cells. Examples include paclitaxol, cytochalasin B, gramicidin D, ethidium bromide, emetine, mitomycin, etoposide, tenoposide, vincristine, vinblastine, colchicin, doxorubicin, daunorubicin, dihydroxy anthracin dione, mitoxantrone, mithramycin, actinomycin D, 1-dehydrotestosterone, glucocorticoids, procaine, tetracaine, lidocaine, propranolol, and puromycin and analogs or homologs thereof. Therapeutic agents include, but are not limited to, antimetabolites (*e.g.*, methotrexate, 6-mercaptopurine, 6-thioguanine, cytarabine, 5-fluorouracil decarbazine), alkylating agents (*e.g.*, mechlorethamine, thioepa chlorambucil, melphalan, carmustine (BSNU) and lomustine (CCNU), cyclothosphamide, busulfan, dibromomannitol, streptozotocin, mitomycin C, and cisdichlorodiamine platinum (II) (DDP) cisplatin), anthracyclines (*e.g.*, daunorubicin (formerly daunomycin) and doxorubicin), antibiotics (*e.g.*, dactinomycin (formerly actinomycin), bleomycin, mithramycin, and anthramycin (AMC)), and anti-mitotic agents (*e.g.*, vincristine and vinblastine).

Further, an antibody or fragment thereof may be conjugated to a therapeutic agent or drug moiety that modifies a given biological response. Therapeutic agents or drug moieties are not to be construed as limited to classical chemical therapeutic agents. For example, the drug moiety may be a protein or polypeptide possessing a desired biological activity. Such proteins may include, for example, a toxin such as abrin, ricin A, pseudomonas exotoxin, or diphtheria toxin; a protein such as tumor necrosis factor, α-interferon, β-interferon, nerve growth factor, platelet derived growth factor, tissue plasminogen activator, an apoptotic agent, *e.g.*, TNF-α, TNF-β, AIM I (see, International Publication No. WO 97/33899), AIM II (see, International Publication No. WO 97/34911), Fas Ligand (Takahashi et al., 1994, J. Iminunol., 6:1567-1574), and VEGI (see, International Publication No. WO 99/23105), a thrombotic agent or an anti-angiogenic agent, *e.g.*, angiostatin or endostatin; or, a biological

response modifier such as, for example, a lymphokine (*e.g.*, interleukin-1 ("IL- 1"), interleukin-2 ("IL-2"), interleukin-6 ("IL-6"), granulocyte macrophage colony stimulating factor ("GM-CSF"), and granulocyte colony stimulating factor ("G-CSF")), or a growth factor (*e.g.*, growth hormone ("GH")).

Techniques for conjugating such therapeutic moieties to antibodies are well known, see, *e.g.*, Arnon *et al.*, "Monoclonal Antibodies For Immunotargeting Of Drugs In Cancer Therapy", in Monoclonal Antibodies And Cancer Therapy, Reisfeld *et al.* (eds.), pp. 243-56 (Alan R. Liss, Inc. 1985); Hellstrom et al., "Antibodies For Drug Delivery", in Controlled Drug Delivery (2nd Ed.), Robinson et al. (eds.), pp. 623-53 (Marcel Dekker, Inc. 1987); Thorpe, "Antibody Carriers Of Cytotoxic Agents In Cancer Therapy: A Review", in Monoclonal Antibodies '84: Biological And Clinical Applications, Pinchera et al. (eds.), pp. 475-506 *(1985);* "Analysis, Results, And Future Prospective Of The Therapeutic Use Of Radiolabeled Antibody In Cancer Therapy", in Monoclonal Antibodies For Cancer Detection And Therapy, Baldwin et al. (eds.), pp. 303-16 (Academic Press 1985), and Thorpe et al., 1982, Immunol. Rev. 62:119-58.

An antibody or fragment thereof, with or without a therapeutic moiety conjugated to it, administered alone or in combination with cytotoxic factor(s) and/or cytokine(s) can be used as a therapeutic.

Alternatively, an antibody can be conjugated to a second antibody to form an antibody heteroconjugate as described by Segal in U.S. Patent No. 4,676,980, which is incorporated herein by reference in its entirety.

Antibodies may also be attached to solid supports, which are particularly useful for immunoassays or purification of the target antigen. Such solid supports include, but are not limited to, glass, cellulose, polyacrylamide, nylon, polystyrene, polyvinyl chloride or polypropylene.

5.2. Prophylactic and Therapeutic Uses of Antibodies

The present invention is directed to antibody-based therapies which involve administering antibodies of the invention or fragments thereof to a mammal, preferably a human, for preventing, treating, or ameliorating one or more symptoms associated with a RSV infection. Prophylactic and therapeutic compounds of the invention include, but are not limited to, antibodies of the invention (including fragments, analogs and derivatives thereof as described herein) and nucleic acids encoding antibodies of the invention (including fragments, analogs and derivatives thereof and anti-idiotypic antibodies as described herein). Antibodies of the invention or fragments thereof may be provided in pharmaceutically acceptable compositions as known in the art or as described herein.

Antibodies of the present invention or fragments thereof that function as antagonists of a RSV infection can be administered to a mammal, preferably a human, to treat, prevent or ameliorate one or more symptoms associated with a RSV infection. For example, antibodies or fragments thereof which disrupt or prevent the interaction between a RSV antigen and its host cell receptor may be administered to a mammal, preferably a human, to treat, prevent or ameliorate one or more symptoms associated with a RSV infection.

In a specific embodiment, an antibody or fragment thereof prevents RSV from binding to its host cell receptor by at least 99%, at least 95%, at least 90%, at least 85%, at least 80%, at least 75%, at least 70%, at least 60%, at least 50%, at least 45%, at least 40%, at least 45%, at least 35%, at least 30%, at least 25%, at least 20%, or at least 10% relative to RSV binding to its host cell receptor in the absence of said antibodies or antibody fragments. In another embodiment, a combination of antibodies, a combination of antibody fragments, or a combination of antibodies and antibody fragments prevent RSV from binding to its host cell receptor by at least 99%, at least 95%, at least 90%, at least 85%, at least 80%, at least 75%, at least 70%, at least 60%, at least 50%, at least 45%, at least 40%, at least 45%, at least 35%, at least 30%, at least 25%, at least 20%, or at least 10% relative to RSV binding to its host cell receptor in the absence of said antibodies and/or antibody fragments.

Antibodies or fragments thereof which do not prevent RSV from binding its host cell receptor but inhibit or downregulate RSV replication can also be administered to a mammal to treat, prevent or ameliorate one or more symptoms associated with a RSV infection. The ability of an antibody or fragment thereof to inhibit or downregulate RSV replication may be determined by techniques described herein or otherwise known in the art. For example, the inhibition or downregulation of RSV replication can be determined by detecting the RSV titer in the lungs of a mammal, preferably a human.

In a specific embodiment, an antibody of the present invention or fragment thereof inhibits or downregulates RSV replication by at least 99%, at least 95%, at least 90%, at least 85%, at least 80%, at least 75%, at least 70%, at least 60%, at least 50%, at least 45%, at least 40%, at least 45%, at least 35%, at least 30%, at least 25%, at least 20%, or at least 10% relative to RSV replication in absence of said antibodies or antibody fragments. In another embodiment, a combination of antibodies, a combination of antibody fragments, or a combination of antibodies and antibody fragments inhibit or downregulate RSV replication by at least 99%, at least 95%, at least 90%, at least 85%, at least 80%, at least 75%, at least 70%, at least 60%, at least 50%, at least 45%, at least 40%, at least 45%, at least 35%, at least 30%, at least 25%, at least 20%, or at least 10% relative to RSV replication in absence of said antibodies and/or antibody fragments.

One or more antibodies of the present invention or fragments thereof that immunospecifically bind to one or more RSV antigens may be used locally or systemically in the body as a therapeutic. The antibodies of this invention or fragments thereof may also be advantageously utilized in combination with other monoclonal or chimeric antibodies, or with lymphokines or hematopoietic growth factors (such as, *e.g.*, IL-2, IL-3 and IL-7), which, for example, serve to increase the number or activity of effector cells which interact with the antibodies. The antibodies of this invention or fragments thereof may also be advantageously utilized in combination with other monoclonal or chimeric antibodies, or with lymphokines or hematopoietic growth factors (such as, *e.g.*, IL-2, IL-3 and IL-7), which, for example, serve to increase the immune response. The antibodies of this invention or fragments thereof may also be advantageously utilized in combination with one or more drugs used to treat RSV infection such as, for example anti-viral agents. Antibodies of the invention or fragments may be used in combination with one or more of the following drugs: NIH-351 (Gemini Technologies), recombinant RSV vaccine (Aviron), RSVf-2 (Intracel), F-50042 (Pierre Fabre), T-786 (Trimeris), VP-36676 (ViroPharma), RFI-641 (American Home Products), VP-14637 (ViroPharma), PFP-1 and PFP-2 (American Home Products), RSV vaccine (Avant Immunotherapeutics), and F-50077 (Pierre Fabre).

The antibodies of the invention may be administered alone or in combination with other types of treatments (*e.g.*, hormonal therapy, immunotherapy, and anti-inflammatory agents). Generally, administration of products of a species origin or species reactivity (in the case of antibodies) that is the same species as that of the patient is preferred. Thus, in a preferred embodiment, human or humanized antibodies, fragments derivatives, analogs, or nucleic acids, are administered to a human patient for therapy or prophylaxis.

It is preferred to use high affinity and/or potent *in vivo* inhibiting antibodies and/or neutralizing antibodies that immunospecifically bind to a RSV antigen, for both immunoassays directed to RSV, prevention of RSV infection and therapy for RSV infection. It is also preferred to use polynucleotides encoding high affinity and/or potent *in vivo* inhibiting antibodies and/or neutralizing antibodies that immunospecifically bind to a RSV antigen, for both immunoassays directed to RSV and therapy for RSV infection. Such antibodies or fragments thereof will preferably have an affinity for the RSV F glycoprotein and/or fragments of the F glycoprotein.

In one embodiment, therapeutic or pharmaceutical compositions comprising antibodies of the invention or fragments thereof are administered to a mammal, preferably a human, to treat, prevent or ameliorate one or more symptoms associated with RSV infection. In another embodiment, therapeutic or pharmaceutical compositions comprising antibodies of the invention or fragments thereof are administered to a human with cystic

fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency, or to a human who has had a bone marrow transplant to treat, prevent or ameliorate one or more symptoms associated with RSV infection. In another embodiment, therapeutic or pharmaceutical compositions comprising antibodies of the invention or fragments thereof are administered to a human infant, preferably a human infant born prematurely or a human infant at risk of hospitalization for RSV infection to treat, prevent or ameliorate one or more symptoms associated with RSV infection. In yet another embodiment, therapeutic or pharmaceutical compositions comprising antibodies of the invention or fragments thereof are administered to the elderly or people in group homes (*e.g.*, nursing homes or rehabilitation centers).

In a specific embodiment, a mammal, preferably a human, is administered a therapeutic or pharmaceutical composition comprising one or more antibodies of the present invention or fragments thereof for the treatment, prevention or amelioration of one or more symptoms associated with a RSV infection in an amount effective for decreasing RSV titers. In accordance with this embodiment, an effective amount of antibodies or antibody fragments reduces the RSV titers in the lung as measured, for example, by the concentration of RSV in sputum samples or a lavage from the lungs from a mammal. In another embodiment, a mammal, preferably a human, is administered a therapeutic or pharmaceutical composition comprising one or more antibodies of the present invention or fragments thereof for the treatment, prevention or amelioration of symptoms associated with a RSV infection in an amount effective for inducing an immune response in the mammal.

In another embodiment, a mammal, preferably a human, is administered a first dose of a therapeutic or pharmaceutical composition comprising less than 15 mg/kg, preferably less than 10 mg/kg, less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg or less than 0.5 mg/kg of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with higher affinity and/or higher avidity than previously known antibodies (*e.g.*, SYNAGIS®) for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a serum titer of at least 1 μg/ml, preferably at least 2 μg/ml, at least 5 μg/ml, at least 10 μg/ml, at least 15 μg/ml, at least 20 μg/ml, or at least 25 μg/ml 20 days (preferably 25, 30, 35, 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, the serum titer of said antibodies or antibody fragments is less than 30 μg/ml 30 days after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, said antibodies have the amino acid sequence of SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

In another embodiment, a mammal, preferably a human, is administered a first dose of a therapeutic or pharmaceutical composition comprising less than 15 mg/kg, preferably less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg or less than 0.5 mg/kg of one or more antibodies or fragments thereof which have increased *in vivo* half-lives and which immunospecifically bind to one or more RSV antigens with higher affinity and/or higher avidity than previously known antibodies (*e.g.*, SYNAGIS®) for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a serum titer of at least 1 μg/ml, preferably at least 2 μg/ml, at least 5 μg/ml, at least 10 μg/ml, at least 15 μg/ml, at least 20 μg/ml, or at least 25 μg/ml 25 days (preferably 30, 35, or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, the serum titer of said antibodies or antibody fragments is less than 30 μg/ml 30 days after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, the novel antibodies have the amino acid sequence of SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

In another embodiment, a mammal, preferably a human, is administered a first dose of a therapeutic or pharmaceutical composition comprising approximately 15 mg/kg of HL-SYNAGIS or antigen-binding fragments thereof for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a serum titer of at least 1 μg/ml, preferably at least 30 μg/ml, at least 35 μg/ml, at least 40 μg/ml, or at least 50 μg/ml 25 days (preferably 30, 35, or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. In another embodiment, a mammal, preferably a human, is administered a first dose of a therapeutic or pharmaceutical composition comprising less than 15 mg/kg (preferably 10 mg/kg or less, 5 mg/kg or less, 3 mg/kg or less, 1 mg/kg or less, or 0.5 mg/kg or less) of HL-SYNAGIS or antigen-binding fragments thereof for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a serum titer of at least 1 μg/ml, preferably at least 30 μg/ml, at least 35 μg/ml, at least 40 μg/ml, or at least 50 μg/ml 25 days (preferably 30, 35, or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose.

The present invention encompasses therapeutic or pharmaceutical compositions for pulmonary delivery comprising one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with a higher affinity and/or a higher avidity than previously known antibodies (*e.g.*, SYNAGIS®). The present invention also

encompasses therapeutic or pharmaceutical compositions for pulmonary delivery comprising SYNAGIS® or an antigen-binding fragment thereof.

In one embodiment, a mammal, preferably a human, is administered a first dose of a therapeutic or pharmaceutical composition for pulmonary delivery comprising less than 15 mg/kg, preferably less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg or less than 0.5 mg/kg, or less than 0.01 mg/kg of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with higher affinity and/or higher avidity than previously known antibodies (*e.g.*, SYNAGIS®) for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a titer of 20 ng per mg of lung protein (preferably at least 40 ng/mg, at least 60 ng/mg, at least 80 ng/mg, at least 50 ng/mg, at least 75 ng/mg, at least 100 ng/mg, or at least 150 ng/mg) in an intubation sample or lavage from the lungs of said mammal 20 days (preferably 25, 30, 35, or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, the serum titer of said antibodies or antibody fragments is less than 100 ng/ml of protein 30 days after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, the novel antibodies have the amino acid sequence of SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

In another embodiment, a mammal, preferably a human, is administered a first dose of a therapeutic or pharmaceutical composition for pulmonary delivery comprising approximately 15 mg/kg of SYNAGIS® or fragments thereof for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a titer of 20 ng per mg of lung protein (preferably at least 40 ng/mg, at least 60 ng/mg, at least 80 ng/mg, at least 50 ng/mg, at least 75 ng/mg, at least 100 ng/mg, or at least 150 ng/mg) an intubation sample or lavage from the lungs of said mammal 30 days (preferably 35 or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. In another embodiment, a mammal, preferably a human, is administered a first dose of a therapeutic or pharmaceutical composition for pulmonary delivery comprising less than 15 mg/kg (preferably 10 mg/kg or less, 5 mg/kg or less, 3 mg/kg or less, 1 mg/kg or less, or 0.5 mg/kg or less) of SYNAGIS® or fragments thereof for the prevention of a RSV infection in an amount effective to induce a titer of 20 ng per mg of lung protein (preferably at least 40 ng/mg, at least 60 ng/mg, at least 80 ng/mg, at least 50 ng/mg, at least 75 ng/mg, at least 100 ng/mg, or at least 150 ng/mg) in an intubation sample or lavage from the lungs of said

mammal 30 days (preferably 35 or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose.

The present invention encompasses therapeutic or pharmaceutical compositions for pulmonary delivery comprising one or more antibodies or fragments thereof which have increased *in vivo* half-lives and which immunospecifically bind to one or more RSV antigens with a higher affinity and/or a higher avidity than previously known antibodies (*e.g.*, SYNAGIS®). The present invention also encompasses therapeutic or pharmaceutical compositions for pulmonary delivery comprising HL-SYNAGIS or an antigen-binding fragment thereof.

The present invention encompasses sustained release compositions comprising one or more antibodies or fragments thereof which have increased *in vivo* half-lives and which immunospecifically bind to one or more RSV antigens with a higher affinity and/or a higher avidity than previously known antibodies (*e.g.*, SYNAGIS®). The present invention also encompasses sustained release compositions comprising SYNAGIS® or an antigen-binding fragment thereof.

In one embodiment, a mammal, preferably a human, is administered a first dose of a sustained release formulation comprising less than 15 mg/kg, preferably less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg or less than 0.5 mg/kg of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with higher affinity and/or higher avidity than previously known antibodies (*e.g.*, SYNAGIS®) for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a serum titer of at least 1 μg/ml, preferably at least 2 μg/ml, at least 5 μg/ml, at least 10 μg/ml, at least 15 μg/ml, at least 20 μg/ml, or at least 25 μg/ml for at least 10 days (preferably at least 15, at least 20, at least 25, at least 30, at least 35, or at least 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, the serum titer of said antibodies or antibody fragments is less than 30 μg/ml 30 days after the administration of the first dose and prior to the administration of a subsequent dose. Preferably, the novel antibodies have the amino acid sequence of SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

In another embodiment, a mammal, preferably a human, is administered a first dose of a sustained release formulation comprising less than 15 mg/kg, preferably less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg or less than 0.5 mg/kg of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens with higher affinity and/or higher avidity than previously known antibodies (*e.g.*,

SYNAGIS®) for the prevention, treatment, or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a serum titer of 1 μg/ml, preferably 2 μg/ml, 5 μg/ml, 10 μg/ml, 15 μg/ml, 20 μg/ml, or 25 μg/ml that is maintained for at least 10 days (preferably at least 15, at least 20, at least 25, at least 30, at least 35, or at least 40 days) after the administration of the first dose and prior to the administration of a subsequent dose without exceeding a serum titer of 30 μg/ml.

In another embodiment, a mammal, preferably a human, is administered a first dose of a sustained release formulation comprising approximately 15 mg/kg of SYNAGIS® or fragments thereof for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a titer of at least 30 μg/ml, preferably at least 35 μg/ml, at least 40 μg/ml, or at least 50 μg/ml 25 days (preferably 30, 35, or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose. In another embodiment, a mammal, preferably a human, is administered a first dose of a sustained release formulation comprising less than 15 mg/kg (preferably 10 mg/kg or less, 5 mg/kg or less, 3 mg/kg or less, 1 mg/kg or less, or 0.5 mg/kg or less) of SYNAGIS® or fragments thereof for the prevention of a RSV infection in an amount effective to induce at least 30 μg/ml, preferably at least 35 μg/ml, at least 40 μg/ml, or at least 50 μg/ml 25 days (preferably 30, 35, or 40 days) after the administration of the first dose and prior to the administration of a subsequent dose.

In another embodiment, a mammal, preferably a human, is administered a first dose of a sustained release formulation comprising less than 15 mg/kg, preferably less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg or less than 0.5 mg/kg of SYNAGIS® or an antigen-binding fragment thereof for the prevention, treatment, or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a serum titer of 1 μg/ml, preferably 2 μg/ml, 5 μg/ml, 10 μg/ml, 15 μg/ml, 20 μg/ml, or 25 μg/ml that is maintained for at least 10 days (preferably at least 15, at least 20, at least 25, at least 30, at least 35, or at least 40 days) after the administration of the first dose and prior to the administration of a subsequent dose without exceeding a serum titer of 30 μg/ml.

The present invention encompasses sustained release formulations comprising one or more antibodies or fragments thereof which have increased *in vivo* half-lives and which immunospecifically bind to one or more RSV antigens with a higher affinity and/or a higher avidity than previously known antibodies such as, *e.g.*, SYNAGIS®. The present invention also encompasses sustained release formulations comprising HL-SYNAGIS or an antigen-binding fragment thereof.

The present invention encompasses sustained release formulations for pulmonary delivery comprising one or more antibodies or fragments thereof which immunospecifically

bind to one or more RSV antigens with a higher affinity and/or a higher avidity than previously known antibodies (*e.g.*, SYNAGIS®). The present invention also encompasses sustained release formulations for pulmonary delivery comprising one or more antibodies or fragments thereof which have increased *in vivo* half-lives and which immunospecifically bind to one or more RSV antigens with a higher affinity and/or a higher avidity than previously known antibodies (*e.g.*, SYNAGIS®). The present invention also encompasses sustained release formulations for pulmonary delivery comprising SYNAGIS® or fragments thereof. The present invention further encompasses sustained release formulations for pulmonary delivery comprising HL-SYNAGIS or an antigen-binding fragment thereof.

In another embodiment, a mammal, preferably a human, is administered a first dose of a therapeutic or pharmaceutical composition comprising less than 10 mg/kg, less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg or less than 0.5 mg/kg of one or more antibodies of the present invention or fragments thereof for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a serum titer of at least 35 μg/ml, at least 40 μg/ml, at least 50 μg/ml, at least 80 μg/ml, at least 100 μg/ml, at least 120 μg/ml, at least 150 μg/ml, at least 200 μg/ml, at least 250 μg/ml, or at least 300 μg/ml 20 days (preferably 25, 30, 35 or 40 days) after the administration of the first dose. In another embodiment, a mammal, preferably a human, is administered a first dose of a therapeutic or pharmaceutical composition comprising approximately 15 mg/kg of one or more antibodies of the present invention or fragments thereof for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a serum titer of at least 100 μg/ml, at least 125 μg/ml, at least 150 μg/ml, at least 200 μg/ml, at least 250 μg/ml, at least 300 μg/ml, at least 350 μg/ml, at least 400 μg/ml, or at least 450 μg/ml 20 days (preferably 25, 30, 35 or 40 days) after the administration of the first dose. The term "approximately 15 mg/kg" as used herein refers to a range of between 14 mg/kg and 16 mg/kg.

In another embodiment, a mammal, preferably a human, is administered a dose of a pharmaceutical composition comprising one or more antibodies of the present invention or fragments thereof for the prevention a RSV infection in an amount effective to induce a prophylactically effective serum titer of less than 10 μg/ml, less than 8 μg/ml, less than 5 μg/ml, less than 3 μg/ml, less than 1 μg/ml, or less than 0.5 μg/ml 30 days after the administration of the dose, wherein said prophylactically effective serum titer is the serum titer that reduces the incidence of RSV infection in the human or the serum titer in a cotton rat that results in a RSV titer 5 days after challenge with 10^5 pfu RSV that is 99% lower than the RSV titer in the cotton rat 5 days after challenge with 10^5 pfu of RSV in a cotton

rat not administered the dose prior to challenge. Preferably, the dose of the pharmaceutical composition comprises less than 10 mg/kg, less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg, or less than 0.5 mg/kg of one or more antibodies of the present invention or fragments thereof.

In yet another embodiment, a mammal, preferably a human, is administered a dose of a therapeutic or pharmaceutical composition comprising one or more antibodies of the present invention or fragments thereof for the treatment or amelioration of one or more symptoms associated with a RSV infection in an amount effective to induce a therapeutically effective serum titer of less than 10 μg/ml, less than 8 μg/ml, less than 5 μg/ml, less than 3 μg/ml, less than 1 μg/ml, or less than 0.5 μg/ml 30 days after the administration of the dose, wherein said therapeutically effective serum titer is the serum titer that reduces the severity or length of RSV infection or is the serum titer in a cotton rat that results in a RSV titer in the rat 5 days after challenge with 10^5 pfu RSV that is 99% lower than the RSV titer 5 days after challenge with 10^5 pfu of RSV in a cotton rat not administered the dose prior to challenge. Preferably, the dose of the therapeutic or pharmaceutical composition comprises less than 12 mg/kg, less than 10 mg/kg, less than 5 mg/kg, less than 3 mg/kg, less than 1 mg/kg, or less than 0.5 mg/kg of one or more antibodies of the present invention or fragments thereof.

5.3. Methods of Administration of Antibodies

The invention provides methods of treatment, prophylaxis, and amelioration of one or more symptoms associated with RSV infection by administrating to a subject of an effective amount of antibody or fragment thereof, or pharmaceutical composition comprising an antibody of the invention or fragment thereof. In a preferred aspect, an antibody or fragment thereof is substantially purified (*i.e.*, substantially free from substances that limit its effect or produce undesired side-effects). The subject is preferably a mammal such as non-primate (*e.g.*, cows, pigs, horses, cats, dogs, rats etc.) and a primate (*e.g.*, monkey such as a cynomolgous monkey and a human). In a preferred embodiment, the subject is a human. In another preferred embodiment, the subject is a human infant or a human infant born prematurely. In another embodiment, the subject is a human with cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency, a human who has had a bone marrow transplant, or an elderly human

Various delivery systems are known and can be used to administer an antibody of the invention or a fragment thereof, *e.g.*, encapsulation in liposomes, microparticles, microcapsules, recombinant cells capable of expressing the antibody or antibody fragment,

receptor-mediated endocytosis (see, *e.g.*, Wu and Wu, J. Biol. Chem. 262:4429-4432 (1987)), construction of a nucleic acid as part of a retroviral or other vector, etc. Methods of administering an antibody or fragment thereof, or pharmaceutical composition include, but are not limited to, parenteral administration (*e.g.*, intradermal, intramuscular, intraperitoneal, intravenous and subcutaneous), epidural, and mucosal (*e.g.*, intranasal and oral routes). In a specific embodiment, antibodies of the present invention or fragments thereof, or pharmaceutical compositions are administered intramuscularly, intravenously, or subcutaneously. The compositions may be administered by any convenient route, for example by infusion or bolus injection, by absorption through epithelial or mucocutaneous linings (*e.g.*, oral mucosa, rectal and intestinal mucosa, etc.) and may be administered together with other biologically active agents. Administration can be systemic or local. In addition, pulmonary administration can also be employed, *e.g.*, by use of an inhaler or nebulizer, and formulation with an aerosolizing agent. See, *e.g.*, U.S. Patent Nos. 6,019,968, 5,985, 320, 5,985,309, 5,934,272, 5,874,064, 5,855,913, 5,290,540, and 4,880,078; and PCT Publication Nos. WO 92/19244, WO 97/32572, WO 97/44013, WO 98/31346, and WO 99/66903, each of which is incorporated herein by reference their entirety. In a preferred embodiment, an antibody of the invention or fragment thereof, or composition of the invention is administered using Alkermes AIR™ pulmonary drug delivery technology (Alkermes, Inc., Cambridge, MA).

The invention provides for any method of administrating lower doses of known antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens than previously thought to be effective for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection. Preferably, lower doses of known antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens are administered by pulmonary administration. The present invention also provides for any method of administering a novel antibody of the invention or fragment thereof for the prevention, treatment or amelioration of one or more symptoms associated with a RSV infection. Preferably, novel antibodies of the invention or fragments thereof are administered by pulmonary administration.

The invention also provides that an antibody or fragment thereof is packaged in a hermetically sealed container such as an ampoule or sachette indicating the quantity of antibody or antibody fragment. In one embodiment, the antibody or antibody fragment is supplied as a dry sterilized lyophilized powder or water free concentrate in a hermetically sealed container and can be reconstituted, *e.g.*, with water or saline to the appropriate concentration for administration to a subject. Preferably, the antibody or antibody fragment is supplied as a dry sterile lyophilized powder in a hermetically sealed container at a unit

dosage of at least 5 mg, more preferably at least 10 mg, at least 15 mg, at least 25 mg, at least 35 mg, at least 45 mg, at least 50 mg, or at least 75 mg. The lyophilized antibody or antibody fragment should be stored at between 2 and 8°C in its original container and the antibody or antibody fragment should be administered within 12 hours, preferably within 6 hours, within 5 hours, within 3 hours, or within 1 hour after being reconstituted. In an alternative embodiment, an antibody or fragment thereof is supplied in liquid form in a hermetically sealed container indicating the quantity and concentration of the antibody or antibody fragment. Preferably, the liquid form of the antibody or fragment thereof is supplied in a hermetically sealed container at least 1 mg/ml, more preferably at least 2.5 mg/ml, at least 5 mg/ml, at least 8 mg/ml, at least 10 mg/ml, at least 15 mg/kg, or at least 25 mg/ml.

In a specific embodiment, it may be desirable to administer the pharmaceutical compositions of the invention locally to the area in need of treatment; this may be achieved by, for example, and not by way of limitation, local infusion, by injection, or by means of an implant, said implant being of a porous, non-porous, or gelatinous material, including membranes, such as sialastic membranes, or fibers. Preferably, when administering a an antibody of the invention or fragment thereof, care must be taken to use materials to which the antibody or antibody fragment does not absorb.

In another embodiment, the composition can be delivered in a vesicle, in particular a liposome (see Langer, Science 249:1527-1533 (1990); Treat *et al.*, in Liposomes in the Therapy of Infectious Disease and Cancer, Lopez-Berestein and Fidler (eds.), Liss, New York, pp. 353- 365 (1989); Lopez-Berestein, ibid., pp. 3 17-327; see generally ibid.).

In yet another embodiment, the composition can be delivered in a controlled release or sustained release system. In one embodiment, a pump may be used to achieve controlled or sustained release (see Langer, supra; Sefton, 1987, CRC Crit. Ref. Biomed. Eng. 14:20; Buchwald et al., 1980, Surgery 88:507; Saudek et al., 1989, N. Engl. J. Med. 321:574). In another embodiment, polymeric materials can be used to achieve controlled or sustained release of the antibodies of the invention or fragments thereof (see *e.g.*, Medical Applications of Controlled Release, Langer and Wise (eds.), CRC Pres., Boca Raton, Florida (1974); Controlled Drug Bioavailability, Drug Product Design and Performance, Smolen and Ball (eds.), Wiley, New York (1984); Ranger and Peppas, 1983, J., Macromol. Sci. Rev. Macromol. Chem. 23:61; see also Levy et al., 1985, Science 228:190; During et al., 1989, Ann. Neurol. 25:351; Howard et al., 1989, J. Neurosurg. 7 1:105); U.S. Patent No. 5,679,377; U.S. Patent No. 5,916,597; U.S. Patent No. 5,912,015; U.S. Patent No. 5,989,463; U.S. Patent No. 5,128,326; PCT Publication No. WO 99/15154; and PCT Publication No. WO 99/20253. Examples of polymers used in sustained release

formulations include, but are not limited to, poly(2-hydroxy ethyl methacrylate), poly(methyl methacrylate), poly(acrylic acid), poly(ethylene-co-vinyl acetate), poly(methacrylic acid), polyglycolides (PLG), polyanhydrides, poly(N-vinyl pyrrolidone), poly(vinyl alcohol), polyacrylamide, poly(ethylene glycol), polylactides (PLA), poly(lactide-co-glycolides) (PLGA), and polyorthoesters. In a preferred embodiment, the polymer used in a sustained release formulation is inert, free of leachable impurities, stable on storage, sterile, and biodegradable. In yet another embodiment, a controlled or sustained release system can be placed in proximity of the therapeutic target, *i.e.*, the lungs, thus requiring only a fraction of the systemic dose (see, *e.g.*, Goodson, in Medical Applications of Controlled Release, supra, vol. 2, pp. 115-138 (1984)).

Controlled release systems are discussed in the review by Langer (1990, Science 249:1527-1533). Any technique known to one of skill in the art can be used to produce sustained release formulations comprising one or more antibodies of the invention or fragments thereof. See, *e.g.*,.U.S. Patent No. 4,526,938, .PCT publication WO 91/05548, PCT publication WO 96/20698,.Ning *et al.*, 1996, "Intratumoral Radioimmunotheraphy of a Human Colon Cancer Xenograft Using a Sustained-Release Gel," Radiotherapy & Oncology 39:179-189,.Song *et al.*, 1995, "Antibody Mediated Lung Targeting of Long-Circulating Emulsions," PDA Journal of Pharmaceutical Science & Technology 50:372-397, Cleek *et al.*, 1997, "Biodegradable Polymeric Carriers for a bFGF Antibody for Cardiovascular Application," Pro. Int'l. Symp. Control. Rel. Bioact. Mater. 24:853-854, and Lam *et al.*, 1997, "Microencapsulation of Recombinant Humanized Monoclonal Antibody for Local Delivery," Proc. Int'l. Symp. Control Rel. Bioact. Mater. 24:759-760, each of which is incorporated herein by reference in their entirety.

In a specific embodiment where the composition of the invention is a nucleic acid encoding an antibody or antibody fragment, the nucleic acid can be administered *in vivo* to promote expression of its encoded antibody or antibody fragment, by constructing it as part of an appropriate nucleic acid expression vector and administering it so that it becomes intracellular, *e.g.*, by use of a retroviral vector (see U.S. Patent No. 4,980,286), or by direct injection, or by use of microparticle bombardment (e.g., a gene gun; Biolistic, Dupont), or coating with lipids or cell-surface receptors or transfecting agents, or by administering it in linkage to a homeobox- like peptide which is known to enter the nucleus (see e.g., Joliot et al., 1991, Proc. Natl. Acad. Sci. USA 88:1864-1868), etc. Alternatively, a nucleic acid can be introduced intracellularly and incorporated within host cell DNA for expression by homologous recombination.

The present invention also provides pharmaceutical compositions. Such compositions comprise a prophylactically or therapeutically effective amount of an antibody

or a fragment thereof, and a pharmaceutically acceptable carrier. In a specific embodiment, the term "pharmaceutically acceptable" means approved by a regulatory agency of the Federal or a state government or listed in the U.S. Pharmacopeia or other generally recognized pharmacopeia for use in animals, and more particularly in humans. The term "carrier" refers to a diluent, adjuvant (*e.g.*, Freund's adjuvant (complete and incomplete)), excipient, or vehicle with which the therapeutic is administered. Such pharmaceutical carriers can be sterile liquids, such as water and oils, including those of petroleum, animal, vegetable or synthetic origin, such as peanut oil, soybean oil, mineral oil, sesame oil and the like. Water is a preferred carrier when the pharmaceutical composition is administered intravenously. Saline solutions and aqueous dextrose and glycerol solutions can also be employed as liquid carriers, particularly for injectable solutions. Suitable pharmaceutical excipients include starch, glucose, lactose, sucrose, gelatin, malt, rice, flour, chalk, silica gel, sodium stearate, glycerol monostearate, talc, sodium chloride, dried skim milk, glycerol, propylene, glycol, water, ethanol and the like. The composition, if desired, can also contain minor amounts of wetting or emulsifying agents, or pH buffering agents. These compositions can take the form of solutions, suspensions, emulsion, tablets, pills, capsules, powders, sustained-release formulations and the like. Oral formulation can include standard carriers such as pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium saccharine, cellulose, magnesium carbonate, etc. Examples of suitable pharmaceutical carriers are described in "Remington's Pharmaceutical Sciences" by E.W. Martin. Such compositions will contain a prophylactically or therapeutically effective amount of the antibody or fragment thereof, preferably in purified form, together with a suitable amount of carrier so as to provide the form for proper administration to the patient. The formulation should suit the mode of administration.

In a preferred embodiment, the composition is formulated in accordance with routine procedures as a pharmaceutical composition adapted for intravenous administration to human beings. Typically, compositions for intravenous administration are solutions in sterile isotonic aqueous buffer. Where necessary, the composition may also include a solubilizing agent and a local anesthetic such as lignocamne to ease pain at the site of the injection.

Generally, the ingredients of compositions of the invention are supplied either separately or mixed together in unit dosage form, for example, as a dry lyophilized powder or water free concentrate in a hermetically sealed container such as an ampoule or sachette indicating the quantity of active agent. Where the composition is to be administered by infusion, it can be dispensed with an infusion bottle containing sterile pharmaceutical grade water or saline. Where the composition is administered by injection, an ampoule of sterile

water for injection or saline can be provided so that the ingredients may be mixed prior to administration.

The compositions of the invention can be formulated as neutral or salt forms. Pharmaceutically acceptable salts include those formed with anions such as those derived from hydrochloric, phosphoric, acetic, oxalic, tartaric acids, etc., and those formed with cations such as those derived from sodium, potassium, ammonium, calcium, ferric hydroxides, isopropylamine, triethylamine, 2-ethylamino ethanol, histidine, procaine, etc.

The amount of the composition of the invention which will be effective in the treatment, prevention or amelioration of one or more symptoms associated with a RSV infection can be determined by standard clinical techniques. For example, the dosage of the composition which will be effective in the treatment, prevention or amelioration of one or more symptoms associated with a RSV infection can be determined by administering the composition to a cotton rat, measuring the RSV titer after challenging the cotton rat with 10^5 pfu of RSV and comparing the RSV titer to that obtain for a cotton rat not administered the composition. Accordingly, a dosage that results in a 2 log decrease or a 99% reduction in RSV titer in the cotton rat challenged with 10^5 pfu of RSV relative to the cotton rat challenged with 10^5 pfu of RSV but not administered the composition is the dosage of the composition that can be administered to a human for the treatment, prevention or amelioration of symptoms associated with RSV infection. The dosage of the composition which will be effective in the treatment, prevention or amelioration of one or more symptoms associated with a RSV infection can be determined by administering the composition to an animal model (*e.g.*, a cotton rat or monkey) and measuring the serum titer of antibodies or fragments thereof that immunospecifically bind to a RSV antigen. Accordingly, a dosage of the composition that results in a serum titer of at least 1 μg/ml, preferably 2 μg/ml, 5 μg/ml, 10 μg/ml, 20 μg/ml, 25 μg/ml, at least 35 μg/ml, at least 40 μg/ml, at least 50 μg/ml, at least 75 μg/ml, at least 100 μg/ml, at least 125 μg/ml, at least 150 μg/ml, at least 200 μg/ml, at least 250 μg/ml, at least 300 μg/ml, at least 350 μg/ml, at least 400 μg/ml, or at least 450 μg/ml can be administered to a human for the treatment, prevention or amelioration of one or more symptoms associated with RSV infection. In addition, *in vitro* assays may optionally be employed to help identify optimal dosage ranges.

The precise dose to be employed in the formulation will also depend on the route of administration, and the seriousness of the RSV infection, and should be decided according to the judgment of the practitioner and each patient's circumstances. Effective doses may be extrapolated from dose-response curves derived from *in vitro* or animal model (*e.g.*, the cotton rat or Cynomolgous monkey) test systems.

For antibodies, the dosage administered to a patient is typically 0.1 mg/kg to 100 mg/kg of the patient's body weight. Preferably, the dosage administered to a patient is between 0.1 mg/kg and 20 mg/kg of the patient's body weight, more preferably 1 mg/kg to 10 mg/kg of the patient's body weight. Generally, human antibodies have a longer half-life within the human body than antibodies from other species due to the immune response to the foreign polypeptides. Thus, lower dosages of human antibodies and less frequent administration is often possible. Further, the dosage and frequency of administration of antibodies of the invention or fragments thereof may be reduced by enhancing uptake and tissue penetration (*e.g.*, into the lung) of the antibodies by modifications such as, for example, lipidation.

In a specific embodiment, antibodies of the invention or fragments thereof, or compositions comprising antibodies of the invention or fragments thereof are administered once a month just prior to or during the RSV season. In another embodiment, antibodies of the invention or fragments thereof, or compositions comprising antibodies of the invention or fragments thereof are administered every two months just prior to or during the RSV season. In yet another embodiment, antibodies of the invention or fragments thereof, or compositions comprising antibodies of the invention or fragments thereof are administered once just prior to or during the RSV season. The term "RSV season" refers to the season when RSV infection is most likely to occur. Typically, the RSV season in the northern hemisphere commences in November and lasts through April.

In one embodiment, approximately 5 mg/kg or less (preferably 1.5 mg/kg or less) of an antibody or fragment thereof which immunospecifically binds to a RSV antigen with a higher avidity and/or higher affinity than previously known antibodies such as, *e.g.*, SYNAGIS®, is administered five times, 3 times, or 1 to 2 times during a RSV season to a mammal, preferably a human. In another embodiment, approximately 1.5 mg/kg of an antibody or a fragment thereof which immunospecifically binds to a RSV antigen with a higher avidity and/or a higher affinity than known antibodies such as, *e.g.*, SYNAGIS®, is administered monthly five times during an RSV season to a mammal, preferably a human, intramuscularly. In another embodiment, 3 mg/kg of an antibody or a fragment thereof which immunospecifically binds to a RSV antigen with a higher avidity and/or a higher affinity than known antibodies such as, *e.g.*, SYNAGIS® is administered monthly three times during an RSV season to a mammal, preferably a human, intramuscularly. In yet another embodiment, 5 mg/kg of an antibody or a fragment thereof which immunospecifically binds to a RSV antigen with a higher avidity and/or a higher affinity than known antibodies such as, *e.g.*, SYNAGIS® is administered monthly one to two times during an RSV season to a mammal, preferably a human, intramuscularly.

In a specific embodiment, 15 mg/kg of HL-SYNAGIS or an antigen-binding fragment thereof is administered to a mammal, preferably a human, intramuscularly five times during an RSV season. In another embodiment, approximately 5 mg/kg or less (preferably 1.5 mg/kg or less) of an antibody or fragment thereof which immunospecifically binds to a RSV antigen with a higher avidity and/or higher affinity than previously known antibodies such as, *e.g.*, SYNAGIS®, is administered five times, 3 times, or 1 to 2 times during a RSV season to a mammal, preferably a human. In another embodiment, 3 mg/kg of antibody or a fragment thereof which immunospecifically binds to a RSV antigen with a higher avidity and/or a higher affinity known antibodies such as, *e.g.*, SYNAGIS® and which has an increased *in vivo* half-life is administered monthly three times during an RSV season to a mammal, preferably a human, intramuscularly. In another embodiment, 5 mg/kg of antibody or a fragment thereof which immunospecifically binds to a RSV antigen with a higher avidity and/or a higher affinity than known antibodies such as, *e.g.*, SYNAGIS® and which has an increased *in vivo* half-life is administered to a mammal, preferably a human, intramuscularly twice times during an RSV season.

In a specific embodiment, an approximately 15 mg/kg bolus of SYNAGIS® or an antigen-binding fragment thereof not in a sustained release formulation is administered to a mammal, preferably a human, and after a certain period of time less than 15 mg/kg (preferably 5 mg/kg or less, more preferably 3 mg/kg or less, and most preferably 1.5 mg/kg or less) of SYNAGIS® or an antibody fragment in a sustained release is administered to said mammal intramuscularly two, three or four times during an RSV season. In accordance with this embodiment, a certain period of time can be 1 to 5 days, a week, two weeks, or a month. In another embodiment, approximately 15 mg/kg or less (preferably at least 2 mg/kg, at least 5 mg/kg, or at least 10 mg/kg) of SYNAGIS® or an antigen-binding fragment thereof in a sustained release formulation is administered to a mammal, preferably a human, intramuscularly two, three or four times during an RSV season.

In another embodiment, approximately 15 mg/kg or less (preferably at least 2 mg/kg, at least 5 mg/kg, or at least 10 mg/kg) of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens is administered to the lungs of a mammal by pulmonary delivery and then after a certain period of time (*e.g.*, 15 minutes, 30 minutes, 45 minutes, 1 hour, 6 hours, 12 hours, 1 day, 5 days, 10 days, 20 days, 25 days, 30 days, or 40 days) approximately 15 mg/kg or less of one or more said antibodies or antibody fragments is administered intramusclarly said mammal. In another embodiment, approximately 15 mg/kg or less (preferably at least 2 mg/kg, at least 5 mg/kg, or at least 10 mg/kg) of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens is administered to a mammal intramusclarly and then after a

certain period of time (*e.g.*, 15 minutes, 30 minutes, 45 minutes, 1 hour, 6 hours, 12 hours, 1 day, 5 days, 10 days, 20 days, 25 days, 30 days, or 40 days) approximately 15 mg/kg or less of one or more said antibodies or antibody fragments is administered to the lungs of said mammal.

5.3.1. Gene Therapy

In a specific embodiment, nucleic acids comprising sequences encoding antibodies or functional derivatives thereof, are administered to treat, prevent or ameliorate one or more symptoms associated with RSV infection, by way of gene therapy. Gene therapy refers to therapy performed by the administration to a subject of an expressed or expressible nucleic acid. In this embodiment of the invention, the nucleic acids produce their encoded antibody or antibody fragment that mediates a prophylactic or therapeutic effect.

Any of the methods for gene therapy available in the art can be used according to the present invention. Exemplary methods are described below.

For general reviews of the methods of gene therapy, see Goldspiel et al., 1993, Clinical Pharmacy 12:488-505; Wu and Wu, 1991, Biotherapy 3:87-95; Tolstoshev, 1993, Ann. Rev. Pharmacol. Toxicol. 32:573-596; Mulligan, Science 260:926-932 (1993); and Morgan and Anderson, 1993, Ann. Rev. Biochem. 62:191-217; May, 1993, TIBTECH 11(5):155-215. Methods commonly known in the art of recombinant DNA technology which can be used are described in Ausubel et al. (eds.), Current Protocols in Molecular Biology, John Wiley & Sons, NY (1993); and Kriegler, Gene Transfer and Expression, A Laboratory Manual, Stockton Press, NY (1990).

In a preferred aspect, a composition of the invention comprises nucleic acids encoding an antibody, said nucleic acids being part of an expression vector that expresses the antibody or fragments or chimeric proteins or heavy or light chains thereof in a suitable host. In particular, such nucleic acids have promoters, preferably heterologous promoters, operably linked to the antibody coding region, said promoter being inducible or constitutive, and, optionally, tissue- specific. In another particular embodiment, nucleic acid molecules are used in which the antibody coding sequences and any other desired sequences are flanked by regions that promote homologous recombination at a desired site in the genome, thus providing for intrachromosomal expression of the antibody encoding nucleic acids (Koller and Smithies, 1989, Proc. Natl. Acad. Sci. USA 86:8932-8935; Zijlstra et al., 1989, Nature 342:435-438). In specific embodiments, the expressed antibody molecule is a single chain antibody; alternatively, the nucleic acid sequences include sequences encoding both the heavy and light chains, or fragments thereof, of the antibody.

Delivery of the nucleic acids into a subject may be either direct, in which case the subject is directly exposed to the nucleic acid or nucleic acid-carrying vectors, or indirect, in which case, cells are first transformed with the nucleic acids in vitro, then transplanted into the subject. These two approaches are known, respectively, as *in vivo* or *ex vivo* gene therapy.

In a specific embodiment, the nucleic acid sequences are directly administered *in vivo*, where it is expressed to produce the encoded product. This can be accomplished by any of numerous methods known in the art, *e.g.*, by constructing them as part of an appropriate nucleic acid expression vector and administering it so that they become intracellular, *e.g.*, by infection using defective or attenuated retrovirals or other viral vectors (see U.S. Patent No. 4,980,286), or by direct injection of naked DNA, or by use of microparticle bombardment (*e.g.*, a gene gun; Biolistic, Dupont), or coating with lipids or cell-surface receptors or transfecting agents, encapsulation in liposomes, microparticles, or microcapsules, or by administering them in linkage to a peptide which is known to enter the nucleus, by administering it in linkage to a ligand subject to receptor-mediated endocytosis (see, *e.g.*, Wu and Wu, 1987, J. Biol. Chem. 262:4429-4432) (which can be used to target cell types specifically expressing the receptors), etc. In another embodiment, nucleic acid-ligand complexes can be formed in which the ligand comprises a fusogenic viral peptide to disrupt endosomes, allowing the nucleic acid to avoid lysosomal degradation. In yet another embodiment, the nucleic acid can be targeted *in vivo* for cell specific uptake and expression, by targeting a specific receptor (see, *e.g.*, PCT Publications WO 92/06180; WO 92/22635; W092/203 16; W093/14188, WO 93/20221). Alternatively, the nucleic acid can be introduced intracellularly and incorporated within host cell DNA for expression, by homologous recombination (Koller and Smithies, 1989, Proc. Natl. Acad. Sci. USA 86:8932-8935; and Zijlstra et al., 1989, Nature 342:435-438).

In a specific embodiment, viral vectors that contains nucleic acid sequences encoding an antibody of the invention or fragments thereof are used. For example, a retroviral vector can be used (see Miller et al., 1993, Meth. Enzymol. 217:581-599). These retroviral vectors contain the components necessary for the correct packaging of the viral genome and integration into the host cell DNA. The nucleic acid sequences encoding the antibody to be used in gene therapy are cloned into one or more vectors, which facilitates delivery of the gene into a subject. More detail about retroviral vectors can be found in Boesen et al., 1994, Biotherapy 6:291-302, which describes the use of a retroviral vector to deliver the mdr 1 gene to hematopoietic stem cells in order to make the stem cells more resistant to chemotherapy. Other references illustrating the use of retroviral vectors in gene therapy are: Clowes et al., 1994, J. Clin. Invest. 93:644-651; Klein et al., 1994, Blood

83:1467-1473; Salmons and Gunzberg, 1993, Human Gene Therapy 4:129-141; and Grossman and Wilson, 1993, Curr. Opin. in Genetics and Devel. 3:110-114.

Adenoviruses are other viral vectors that can be used in gene therapy. Adenoviruses are especially attractive vehicles for delivering genes to respiratory epithelia. Adenoviruses naturally infect respiratory epithelia where they cause a mild disease. Other targets for adenovirus-based delivery systems are liver, the central nervous system, endothelial cells, and muscle. Adenoviruses have the advantage of being capable of infecting non-dividing cells. Kozarsky and Wilson, 1993, Current Opinion in Genetics and Development 3:499-503 present a review of adenovirus-based gene therapy. Bout et al., 1994, Human Gene Therapy 5:3-10 demonstrated the use of adenovirus vectors to transfer genes to the respiratory epithelia of rhesus monkeys. Other instances of the use of adenoviruses in gene therapy can be found in Rosenfeld et al., 1991, Science 252:431-434; Rosenfeld et al., 1992, Cell 68:143-155; Mastrangeli et al., 1993, J. Clin. Invest. 91:225-234; PCT Publication W094/12649; and Wang et al., 1995, Gene Therapy 2:775-783. In a preferred embodiment, adenovirus vectors are used.

Adeno-associated virus (AAV) has also been proposed for use in gene therapy (Walsh et al., 1993, Proc. Soc. Exp. Biol. Med. 204:289-300; and U.S. Patent No. 5,436,146).

Another approach to gene therapy involves transferring a gene to cells in tissue culture by such methods as electroporation, lipofection, calcium phosphate mediated transfection, or viral infection. Usually, the method of transfer includes the transfer of a selectable marker to the cells. The cells are then placed under selection to isolate those cells that have taken up and are expressing the transferred gene. Those cells are then delivered to a subject.

In this embodiment, the nucleic acid is introduced into a cell prior to administration *in vivo* of the resulting recombinant cell. Such introduction can be carried out by any method known in the art, including but not limited to transfection, electroporation, microinjection, infection with a viral or bacteriophage vector containing the nucleic acid sequences, cell fusion, chromosome-mediated gene transfer, microcellmediated gene transfer, spheroplast fusion, etc. Numerous techniques are known in the art for the introduction of foreign genes into cells (see, *e.g.*, Loeffler and Behr, 1993, Meth. Enzymol. 217:599-618; Cohen et al., 1993, Meth. Enzymol. 217:618-644; Clin. Pharma. Ther. 29:69-92 (1985)) and may be used in accordance with the present invention, provided that the necessary developmental and physiological functions of the recipient cells are not disrupted. The technique should provide for the stable transfer of the nucleic acid to the cell, so that

the nucleic acid is expressible by the cell and preferably heritable and expressible by its cell progeny.

The resulting recombinant cells can be delivered to a subject by various methods known in the art. Recombinant blood cells (*e.g.*, hematopoietic stem or progenitor cells) are preferably administered intravenously. The amount of cells envisioned for use depends on the desired effect, patient state, etc., and can be determined by one skilled in the art.

Cells into which a nucleic acid can be introduced for purposes of gene therapy encompass any desired, available cell type, and include but are not limited to epithelial cells, endothelial cells, keratinocytes, fibroblasts, muscle cells, hepatocytes; blood cells such as T lymphocytes, B lymphocytes, monocytes, macrophages, neutrophils, eosinophils, megakaryocytes, granulocytes; various stem or progenitor cells, in particular hematopoietic stem or progenitor cells, *e.g.*, as obtained from bone marrow, umbilical cord blood, peripheral blood, fetal liver, etc.

In a preferred embodiment, the cell used for gene therapy is autologous to the subject.

In an embodiment in which recombinant cells are used in gene therapy, nucleic acid sequences encoding an antibody or fragment thereof are introduced into the cells such that they are expressible by the cells or their progeny, and the recombinant cells are then administered *in vivo* for therapeutic effect. In a specific embodiment, stem or progenitor cells are used. Any stem and/or progenitor cells which can be isolated and maintained *in vitro* can potentially be used in accordance with this embodiment of the present invention (see *e.g.*, PCT Publication WO 94/08598; Stemple and Anderson, 1992, Cell 7 1:973-985; Rheinwald, 1980, Meth. Cell Bio. 21A:229; and Pittelkow and Scott, 1986, Mayo Clinic Proc. 61:771).

In a specific embodiment, the nucleic acid to be introduced for purposes of gene therapy comprises an inducible promoter operably linked to the coding region, such that expression of the nucleic acid is controllable by controlling the presence or absence of the appropriate inducer of transcription.

5.4. Antibody Characterization and Demonstration of Therapeutic or Prophylactic Utility

Antibodies of the present invention or fragments thereof may be characterized in a variety of ways. In particular, antibodies of the invention or fragments thereof may be assayed for the ability to immunospecifically bind to a RSV antigen. Such an assay may be performed in solution (*e.g.*, Houghten, 1992, Bio/Techniques 13:412-421), on beads (Lam, 1991, Nature 354:82-84), on chips (Fodor, 1993, Nature 364:555-556), on bacteria (U.S. Patent No. 5,223,409), on spores (U.S. Patent Nos. 5,571,698; 5,403,484; and 5,223,409),

on plasmids (Cull et al., 1992, Proc. Natl. Acad. Sci. USA 89:1865-1869) or on phage (Scott and Smith, 1990, Science 249:386-390; Devlin, 1990, Science 249:404-406; Cwirla et al., 1990, Proc. Natl. Acad. Sci. USA 87:6378-6382; and Felici, 1991, J. Mol. Biol. 222:301-310) (each of these references is incorporated herein in its entirety by reference). Antibodies or fragments thereof that have been identified to immunospecifically bind to a RSV antigen or a fragment thereof can then be assayed for their specificity and affinity for a RSV antigen.

The antibodies of the invention or fragments thereof may be assayed for immunospecific binding to a RSV antigen and cross-reactivity with other antigens by any method known in the art. Immunoassays which can be used to analyze immunospecific binding and cross-reactivity include, but are not limited to, competitive and non-competitive assay systems using techniques such as western blots, radioimmunoassays, ELISA (enzyme linked immunosorbent assay), "sandwich" immunoassays, immunoprecipitation assays, precipitin reactions, gel diffusion precipitin reactions, immunodiffusion assays, agglutination assays, complement-fixation assays, immunoradiometric assays, fluorescent immunoassays, protein A immunoassays, to name but a few. Such assays are routine and well known in the art (see, *e.g.*, Ausubel et al, eds, 1994, Current Protocols in Molecular Biology, Vol. 1, John Wiley & Sons, Inc., New York, which is incorporated by reference herein in its entirety). Exemplary immunoassays are described briefly below (but are not intended by way of limitation).

Immunoprecipitation protocols generally comprise lysing a population of cells in a lysis buffer such as RIPA buffer (1% NP-40 or Triton X-100, 1% sodium deoxycholate, 0.1% SDS, 0.15 M NaCl, 0.01 M sodium phosphate at pH 7.2, 1% Trasylol) supplemented with protein phosphatase and/or protease inhibitors (*e.g.*, EDTA, PMSF, aprotinin, sodium vanadate), adding the antibody of interest to the cell lysate, incubating for a period of time (*e.g.*, 1 to 4 hours) at 40° C, adding protein A and/or protein G sepharose beads to the cell lysate, incubating for about an hour or more at 40° C, washing the beads in lysis buffer and resuspending the beads in SDS/sample buffer. The ability of the antibody of interest to immunoprecipitate a particular antigen can be assessed by, *e.g.*, western blot analysis. One of skill in the art would be knowledgeable as to the parameters that can be modified to increase the binding of the antibody to an antigen and decrease the background (*e.g.*, pre-clearing the cell lysate with sepharose beads). For further discussion regarding immunoprecipitation protocols see, *e.g.*, Ausubel et al, eds, 1994, Current Protocols in Molecular Biology, Vol. 1, John Wiley & Sons, Inc., New York at 10.16.1.

Western blot analysis generally comprises preparing protein samples, electrophoresis of the protein samples in a polyacrylamide gel (*e.g.*, 8%- 20% SDS-PAGE depending on the

molecular weight of the antigen), transferring the protein sample from the polyacrylamide gel to a membrane such as nitrocellulose, PVDF or nylon, blocking the membrane in blocking solution (*e.g.*, PBS with 3% BSA or non-fat milk), washing the membrane in washing buffer (*e.g.*, PBS-Tween 20), blocking the membrane with primary antibody (the antibody of interest) diluted in blocking buffer, washing the membrane in washing buffer, blocking the membrane with a secondary antibody (which recognizes the primary antibody, *e.g.*, an anti-human antibody) conjugated to an enzymatic substrate (*e.g.*, horseradish peroxidase or alkaline phosphatase) or radioactive molecule (*e.g.*, ^{32}P or ^{125}I) diluted in blocking buffer, washing the membrane in wash buffer, and detecting the presence of the antigen. One of skill in the art would be knowledgeable as to the parameters that can be modified to increase the signal detected and to reduce the background noise. For further discussion regarding western blot protocols see, *e.g.*, Ausubel et al, eds, 1994, Current Protocols in Molecular Biology, Vol. 1, John Wiley & Sons, Inc., New York at 10.8.1.

ELISAs comprise preparing antigen, coating the well of a 96 well microtiter plate with the antigen, adding the antibody of interest conjugated to a detectable compound such as an enzymatic substrate (*e.g.*, horseradish peroxidase or alkaline phosphatase) to the well and incubating for a period of time, and detecting the presence of the antigen. In ELISAs the antibody of interest does not have to be conjugated to a detectable compound; instead, a second antibody (which recognizes the antibody of interest) conjugated to a detectable compound may be added to the well. Further, instead of coating the well with the antigen, the antibody may be coated to the well. In this case, a second antibody conjugated to a detectable compound may be added following the addition of the antigen of interest to the coated well. One of skill in the art would be knowledgeable as to the parameters that can be modified to increase the signal detected as well as other variations of ELISAs known in the art. For further discussion regarding ELISAs see, *e.g.*, Ausubel et al, eds, 1994, Current Protocols in Molecular Biology, Vol. 1, John Wiley & Sons, Inc., New York at 11.2.1.

The binding affinity of an antibody to an antigen and the off-rate of an antibody-antigen interaction can be determined by competitive binding assays. One example of a competitive binding assay is a radioimmunoassay comprising the incubation of labeled antigen (*e.g.*, ^{3}H or ^{125}I) with the antibody of interest in the presence of increasing amounts of unlabeled antigen, and the detection of the antibody bound to the labeled antigen. The affinity of the antibody of the present invention or a fragment thereof for a RSV antigen and the binding off-rates can be determined from the data by scatchard plot analysis. Competition with a second antibody can also be determined using radioimmunoassays. In this case, a RSV antigen is incubated with an antibody of the present invention or a

fragment thereof conjugated to a labeled compound (*e.g.*, ^{3}H or ^{125}I) in the presence of increasing amounts of an unlabeled second antibody.

In a preferred embodiment, BIAcore kinetic analysis is used to determine the binding on and off rates of antibodies or fragments thereof to a RSV antigen. BIAcore kinetic analysis comprises analyzing the binding and dissociation of a RSV antigen from chips with immobilized antibodies or fragments thereof on their surface (see the Example section *infra*).

The antibodies of the invention or fragments thereof can also be assayed for their ability to inhibit the binding of RSV to its host cell receptor using techniques known to those of skill in the art. For example, cells expressing the receptor for RSV can be contacted with RSV in the presence or absence of an antibody or fragment thereof and the ability of the antibody or fragment thereof to inhibit RSV's binding can measured by, for example, flow cytometry or a scintillation assay. RSV (*e.g.*, a RSV antigen such as F glycoprotein or G glycoprotein) or the antibody or antibody fragment can be labeled with a detectable compound such as a radioactive label (*e.g.*, ^{32}P, ^{35}S, and ^{125}I) or a fluorescent label (*e.g.*, fluorescein isothiocyanate, rhodamine, phycoerythrin, phycocyanin, allophycocyanin, o-phthaldehyde and fluorescamine) to enable detection of an interaction between RSV and its host cell receptor. Alternatively, the ability of antibodies or fragments thereof to inhibit RSV from binding to its receptor can be determined in cell-free assays. For example, RSV or a RSV antigen such as G glycoprotein can be contacted with an antibody or fragment thereof and the ability of the antibody or antibody fragment to inhibit RSV or the RSV antigen from binding to its host cell receptor can be determined. Preferably, the antibody or the antibody fragment is immobilized on a solid support and RSV or a RSV antigen is labeled with a detectable compound. Alternatively, RSV or a RSV antigen is immobilized on a solid support and the antibody or fragment thereof is labeled with a detectable compound. RSV or a RSV antigen may be partially or completely purified (*e.g.*, partially or completely free of other polypeptides) or part of a cell lysate. Further, an RSV antigen may be a fusion protein comprising the RSV antigen and a domain such as glutathionine-S-transferase. Alternatively, an RSV antigen can be biotinylated using techniques well known to those of skill in the art (*e.g.*, biotinylation kit, Pierce Chemicals; Rockford, IL).

The antibodies of the invention or fragments thereof can also be assayed for their ability to inhibit or downregulate RSV replication using techniques known to those of skill in the art. For example, RSV replication can be assayed by a plaque assay such as described, *e.g.*, by Johnson et al., 1997, Journal of Infectious Diseases 176:1215-1224. The antibodies of the invention or fragments thereof can also be assayed for their ability to

inhibit or downregulate the expression of RSV polypeptides. Techniques known to those of skill in the art, including, but not limited to, Western blot analysis, Northern blot analysis, and RT-PCR can be used to measure the expression of RSV polypeptides. Further, the antibodies of the invention or fragments thereof can be assayed for their ability to prevent the formation of syncytia.

The antibodies of the invention or fragments thereof are preferably tested *in vitro*, and then *in vivo* for the desired therapeutic or prophylactic activity, prior to use in humans. For example, *in vitro* assays which can be used to determine whether administration of a specific antibody or composition of the present invention is indicated, include *in vitro* cell culture assays in which a subject tissue sample is grown in culture, and exposed to or otherwise administered an antibody or composition of the present invention, and the effect of such an antibody or composition of the present invention upon the tissue sample is observed. In various specific embodiments, *in vitro* assays can be carried out with representative cells of cell types involved in a RSV infection (*e.g.*, respiratory epithelial cells), to determine if an antibody or composition of the present invention has a desired effect upon such cell types. Preferably, the antibodies or compositions of the invention are also tested in *in vitro* assays and animal model systems prior to administration to humans. In a specific embodiment, cotton rats are administered an antibody the invention or fragment thereof, or a composition of the invention, challenged with 10^5 pfu of RSV, and four or more days later the rats are sacrificed and RSV titer and anti-RSV antibody serum titer is determined. Further, in accordance with this embodiment, the tissues (*e.g.*, the lung tissues) from the sacrificed rats can be examined for histological changes.

In accordance with the invention, clinical trials with human subjects need not be performed in order to demonstrate the prophylactic and/or therapeutic efficacy of antibodies of the invention or fragments thereof. *In vitro* and animal model studies using the antibodies or fragments thereof can be extrapolated to humans and are sufficient for demonstrating the prophylactic and/or therapeutic utility of said antibodies or antibody fragments.

Antibodies or compositions of the present invention for use in therapy can be tested for their toxicity in suitable animal model systems, including but not limited to rats, mice, cows, monkeys, and rabbits. For *in vivo* testing of an antibody or composition's toxicity any animal model system known in the art may be used.

Efficacy in treating or preventing viral infection may be demonstrated by detecting the ability of an antibody or composition of the invention to inhibit the replication of the virus, to inhibit transmission or prevent the virus from establishing itself in its host, to reduce the incidence of RSV infection, or to prevent, ameliorate or alleviate one or more

symptoms associated with RSV infection. The treatment is considered therapeutic if there is, for example, a reduction is viral load, amelioration of one or more symptoms, a reduction in the duration of a RSV infection, or a decrease in mortality and/or morbidity following administration of an antibody or composition of the invention. Further, the treatment is considered therapeutic if there is an increase in the immune response following the administration of one or more antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens.

Antibodies or compositions of the invention can be tested *in vitro* and *in vivo* for the ability to induce the expression of cytokines such as IFN-α, IFN-β, IFN-γ, IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-12 and IL-15. Techniques known to those of skill in the art can be used to measure the level of expression of cytokines. For example, the level of expression of cytokines can be measured by analyzing the level of RNA of cytokines by, for example, RT-PCR and Northern blot analysis, and by analyzing the level of cytokines by, for example, immunoprecipitation followed by western blot analysis and ELISA. In a preferred embodiment, an antibody or composition of the invention is tested for its ability to induce the expression of IFN-γ.

Antibodies or compositions of the invention can be tested *in vitro* and *in vivo* for their ability to modulate the biological activity of immune cells, preferably human immune cells (*e.g.*, T-cells, B-cells, and Natural Killer cells). The ability of an antibody or composition of the invention to modulate the biological activity of immune cells can be assessed by detecting the expression of antigens, detecting the proliferation of immune cells, detecting the activation of signaling molecules, detecting the effector function of immune cells, or detecting the differentiation of immune cells. Techniques known to those of skill in the art can be used for measuring these activities. For example, cellular proliferation can be assayed by ^{3}H-thymidine incorporation assays and trypan blue cell counts. Antigen expression can be assayed, for example, by immunoassays including, but are not limited to, competitive and non-competitive assay systems using techniques such as western blots, immunohistochemistry radioimmunoassays, ELISA (enzyme linked immunosorbent assay), "sandwich" immunoassays, immunoprecipitation assays, precipitin reactions, gel diffusion precipitin reactions, immunodiffusion assays, agglutination assays, complement-fixation assays, immunoradiometric assays, fluorescent immunoassays, protein A immunoassays and FACS analysis. The activation of signaling molecules can be assayed, for example, by kinase assays and electrophoretic shift assays (EMSAs).

Antibodies or compositions of the invention can also be tested for their ability to inhibit viral replication or reduce viral load in *in vitro*, *ex vivo* and *in vivo* assays. Antibodies or compositions of the invention can also be tested for their ability to decrease

the time course of RSV infection. Antibodies or compositions of the invention can also be tested for their ability to increase the survival period of humans suffering from RSV infection by at least 25%, preferably at least 50%, at least 60%, at least 75%, at least 85%, at least 95%, or at least 99%. Further, antibodies or compositions of the invention can be tested for their ability reduce the hospitalization period of humans suffering from RSV infection by at least 60%, preferably at least 75%, at least 85%, at least 95%, or at least 99%. Techniques known to those of skill in the art can be used to analyze the function of the antibodies or compositions of the invention *in vivo*.

5.5. Diagnostic Uses of Antibodies

Labeled antibodies, fragments and derivatives and analogs thereof, which immunospecifically bind to a RSV antigen can be used for diagnostic purposes to detect, diagnose, or monitor a RSV infection. The invention provides for the detection of a RSV infection, comprising: (a) assaying the expression of a RSV antigen in cells or a tissue sample of a subject using one or more antibodies or fragments thereof that immunospecifically bind to the RSV antigen; and (b) comparing the level of the RSV antigen with a control level, *e.g.*, levels in normal tissue samples not infected with RSV, whereby an increase in the assayed level of RSV antigen compared to the control level of the RSV antigen is indicative of a RSV infection.

The invention provides a diagnostic assay for diagnosing a RSV infection, comprising: (a) assaying for the level of a RSV antigen in cells or a tissue sample of an individual using one or more antibodies or fragments thereof that immunospecifically bind to a RSV antigen; and (b) comparing the level of the RSV antigen with a control level, *e.g.*, levels in normal tissue samples not infected with RSV, whereby an increase in the assayed RSV antigen level compared to the control level of the RSV antigen is indicative of a RSV infection. A more definitive diagnosis of RSV infection may allow health professionals to employ preventative measures or aggressive treatment earlier thereby preventing the development or further progression of RSV infection.

Antibodies of the invention or fragments thereof can be used to assay RSV antigen levels in a biological sample using classical immunohistological methods as described herein or as known to those of skill in the art (*e.g.*, see Jalkanen et al., 1985, J. Cell. Biol. 101:976-985; and Jalkanen et al., 1987, J. Cell . Biol. 105:3087-3096). Other antibody-based methods useful for detecting protein gene expression include immunoassays, such as the enzyme linked immunosorbent assay (ELISA) and the radioimmunoassay (RIA). Suitable antibody assay labels are known in the art and include enzyme labels, such as, glucose oxidase; radioisotopes, such as iodine (^{125}I, ^{121}I), carbon (^{14}C), sulfur (^{35}S), tritium

(^{3}H), indium (^{121}In), and technetium (^{99}Tc); luminescent labels, such as luminol; and fluorescent labels, such as fluorescein and rhodamine, and biotin.

One aspect of the invention is the detection and diagnosis of a RSV infection in a human. In one embodiment, diagnosis comprises: a) administering (for example, parenterally, subcutaneously, or intraperitoneally) to a subject an effective amount of a labeled antibody or fragment thereof that immunospecifically binds to a RSV antigen; b) waiting for a time interval following the administering for permitting the labeled antibody or fragment thereof to preferentially concentrate at sites in the subject (*e.g.*, the lungs) where the RSV antigen is expressed (and for unbound labeled molecule to be cleared to background level); c) determining background level; and d) detecting the labeled antibody or fragment thereof in the subject, such that detection of labeled antibody or fragment thereof above the background level indicates that the subject has a RSV infection. Background level can be determined by various methods including, comparing the amount of labeled molecule detected to a standard value previously determined for a particular system.

It will be understood in the art that the size of the subject and the imaging system used will determine the quantity of imaging moiety needed to produce diagnostic images. In the case of a radioisotope moiety, for a human subject, the quantity of radioactivity injected will normally range from about 5 to 20 millicuries of ^{99}Tc. The labeled antibody or antibody fragment will then preferentially accumulate at the location of cells which contain the specific protein. *In vivo* tumor imaging is described in S.W. Burchiel *et al.*, "Immunopharmacokinetics of Radiolabeled Antibodies and Their Fragments." (Chapter 13 in Tumor Imaging: The Radiochemical Detection of Cancer, S.W. Burchiel and B. A. Rhodes, eds., Masson Publishing Inc. (1982).

Depending on several variables, including the type of label used and the mode of administration, the time interval following the administration for permitting the labeled molecule to preferentially concentrate at sites in the subject and for unbound labeled molecule to be cleared to background level is 6 to 48 hours or 6 to 24 hours or 6 to 12 hours. In another embodiment the time interval following administration is 5 to 20 days or 5 to 10 days.

In one embodiment, monitoring of a RSV infection is carried out by repeating the method for diagnosing the RSV infection, for example, one month after initial diagnosis, six months after initial diagnosis, one year after initial diagnosis, etc.

Presence of the labeled molecule can be detected in the subject using methods known in the art for *in vivo* scanning. These methods depend upon the type of label used. Skilled artisans will be able to determine the appropriate method for detecting a particular

label. Methods and devices that may be used in the diagnostic methods of the invention include, but are not limited to, computed tomography (CT), whole body scan such as position emission tomography (PET), magnetic resonance imaging (MRI), and sonography.

In a specific embodiment, the molecule is labeled with a radioisotope and is detected in the patient using a radiation responsive surgical instrument (Thurston et al., U.S. Patent No. 5,441,050). In another embodiment, the molecule is labeled with a fluorescent compound and is detected in the patient using a fluorescence responsive scanning instrument. In another embodiment, the molecule is labeled with a positron emitting metal and is detected in the patient using positron emission-tomography. In yet another embodiment, the molecule is labeled with a paramagnetic label and is detected in a patient using magnetic resonance imaging (MRI).

5.6. Methods Producing Antibodies

The antibodies of the invention or fragments thereof can be produced by any method known in the art for the synthesis of antibodies, in particular, by chemical synthesis or preferably, by recombinant expression techniques.

Polyclonal antibodies to a RSV antigen can be produced by various procedures well known in the art. For example, a RSV antigen can be administered to various host animals including, but not limited to, rabbits, mice, rats, etc. to induce the production of sera containing polyclonal antibodies specific for the RSV antigen. Various adjuvants may be used to increase the immunological response, depending on the host species, and include but are not limited to, Freund's (complete and incomplete), mineral gels such as aluminum hydroxide, surface active substances such as lysolecithin, pluronic polyols, polyanions, peptides, oil emulsions, keyhole limpet hemocyanins, dinitrophenol, and potentially useful human adjuvants such as BCG (bacille Calmette-Guerin) and corynebacterium parvum. Such adjuvants are also well known in the art.

Monoclonal antibodies can be prepared using a wide variety of techniques known in the art including the use of hybridoma, recombinant, and phage display technologies, or a combination thereof. For example, monoclonal antibodies can be produced using hybridoma techniques including those known in the art and taught, for example, in Harlow *et al.*, *Antibodies: A Laboratory Manual*, (Cold Spring Harbor Laboratory Press, 2nd ed. 1988); Hammerling, *et al.*, in: *Monoclonal Antibodies and T-Cell Hybridomas* 563-681 (Elsevier, N.Y., 1981) (said references incorporated by reference in their entireties). The term "monoclonal antibody" as used herein is not limited to antibodies produced through hybridoma technology. The term "monoclonal antibody" refers to an antibody that is

derived from a single clone, including any eukaryotic, prokaryotic, or phage clone, and not the method by which it is produced.

Methods for producing and screening for specific antibodies using hybridoma technology are routine and well known in the art. Briefly, mice can be immunized with a RSV antigen and once an immune response is detected, *e.g.,* antibodies specific for the RSV antigen are detected in the mouse serum, the mouse spleen is harvested and splenocytes isolated. The splenocytes are then fused by well known techniques to any suitable myeloma cells, for example cells from cell line SP20 available from the ATCC. Hybridomas are selected and cloned by limited dilution. The hybridoma clones are then assayed by methods known in the art for cells that secrete antibodies capable of binding a polypeptide of the invention. Ascites fluid, which generally contains high levels of antibodies, can be generated by immunizing mice with positive hybridoma clones.

Accordingly, the present invention provides methods of generating monoclonal antibodies as well as antibodies produced by the method comprising culturing a hybridoma cell secreting an antibody of the invention wherein, preferably, the hybridoma is generated by fusing splenocytes isolated from a mouse immunized with a RSV antigen with myeloma cells and then screening the hybridomas resulting from the fusion for hybridoma clones that secrete an antibody able to bind a RSV antigen.

Antibody fragments which recognize specific RSV epitopes may be generated by any technique known to those of skill in the art. For example, Fab and F(ab')2 fragments of the invention may be produced by proteolytic cleavage of immunoglobulin molecules, using enzymes such as papain (to produce Fab fragments) or pepsin (to produce F(ab')2 fragments). F(ab')2 fragments contain the variable region, the light chain constant region and the CH1 domain of the heavy chain. Further, the antibodies of the present invention can also be generated using various phage display methods known in the art.

In phage display methods, functional antibody domains are displayed on the surface of phage particles which carry the polynucleotide sequences encoding them. In particular, DNA sequences encoding VH and VL domains are amplified from animal cDNA libraries (*e.g.*, human or murine cDNA libraries of lymphoid tissues). The DNA encoding the VH and VL domains are recombined together with an scFv linker by PCR and cloned into a phagemid vector (*e.g.*, p CANTAB 6 or pComb 3 HSS). The vector is electroporated in *E. coli* and the E. coli is infected with helper phage. Phage used in these methods are typically filamentous phage including fd and M13 and the VH and VL domains are usually recombinantly fused to either the phage gene III or gene VIII. Phage expressing an antigen binding domain that binds to a RSV antigen of interest can be selected or identified with antigen, *e.g.*, using labeled antigen or antigen bound or captured to a solid surface or bead.

Examples of phage display methods that can be used to make the antibodies of the present invention include those disclosed in Brinkman et al., 1995, J. Immunol. Methods 182:41-50; Ames et al., 1995, J. Immunol. Methods 184:177-186; Kettleborough et al., 1994, Eur. J. Immunol. 24:952-958; Persic et al., 1997, Gene 187:9-18; Burton et al., 1994, Advances in Immunology 57:191-280; PCT application No. PCT/GB91/O1 134; PCT publication Nos. WO 90/02809, WO 91/10737, WO 92/01047, WO 92/18619, WO 93/1 1236, WO 95/15982, WO 95/20401, and WO97/13844; and U.S. Patent Nos. 5,698,426, 5,223,409, 5,403,484, 5,580,717, 5,427,908, 5,750,753, 5,821,047, 5,571,698, 5,427,908, 5,516,637, 5,780,225, 5,658,727, 5,733,743 and 5,969,108; each of which is incorporated herein by reference in its entirety.

As described in the above references, after phage selection, the antibody coding regions from the phage can be isolated and used to generate whole antibodies, including human antibodies, or any other desired antigen binding fragment, and expressed in any desired host, including mammalian cells, insect cells, plant cells, yeast, and bacteria, *e.g.*, as described below. Techniques to recombinantly produce Fab, Fab' and F(ab')2 fragments can also be employed using methods known in the art such as those disclosed in PCT publication No. WO 92/22324; Mullinax et al., 1992, BioTechniques 12(6):864-869; Sawai et al., 1995, AJRI 34:26-34; and Better et al., 1988, Science 240:1041-1043 (said references incorporated by reference in their entireties).

To generate whole antibodies, PCR primers including VH or VL nucleotide sequences, a restriction site, and a flanking sequence to protect the restriction site can be used to amplify the VH or VL sequences in scFv clones. Utilizing cloning techniques known to those of skill in the art, the PCR amplified VH domains can be cloned into vectors expressing a VH constant region, *e.g.*, the human gamma 4 constant region, and the PCR amplified VL domains can be cloned into vectors expressing a VL constant region, *e.g.*, human kappa or lamba constant regions. Preferably, the vectors for expressing the VH or VL domains comprise an EF-1α promoter, a secretion signal, a cloning site for the variable domain, constant domains, and a selection marker such as neomycin. The VH and VL domains may also cloned into one vector expressing the necessary constant regions. The heavy chain conversion vectors and light chain conversion vectors are then co-transfected into cell lines to generate stable or transient cell lines that express full-length antibodies, *e.g.*, IgG, using techniques known to those of skill in the art.

For some uses, including *in vivo* use of antibodies in humans and *in vitro* detection assays, it may be preferable to use human or chimeric antibodies. Completely human antibodies are particularly desirable for therapeutic treatment of human subjects. Human antibodies can be made by a variety of methods known in the art including phage display

methods described above using antibody libraries derived from human immunoglobulin sequences. See also U.S. Patent Nos. 4,444,887 and 4,716,111; and PCT publications WO 98/46645, WO 98/50433, WO 98/24893, WO98/16654, WO 96/34096, WO 96/33735, and WO 91/10741; each of which is incorporated herein by reference in its entirety.

Human antibodies can also be produced using transgenic mice which are incapable of expressing functional endogenous immunoglobulins, but which can express human immunoglobulin genes. For example, the human heavy and light chain immunoglobulin gene complexes may be introduced randomly or by homologous recombination into mouse embryonic stem cells. Alternatively, the human variable region, constant region, and diversity region may be introduced into mouse embryonic stem cells in addition to the human heavy and light chain genes. The mouse heavy and light chain immunoglobulin genes may be rendered non-functional separately or simultaneously with the introduction of human immunoglobulin loci by homologous recombination. In particular, homozygous deletion of the J_H region prevents endogenous antibody production. The modified embryonic stem cells are expanded and microinjected into blastocysts to produce chimeric mice. The chimeric mice are then be bred to produce homozygous offspring which express human antibodies. The transgenic mice are immunized in the normal fashion with a selected antigen, *e.g.*, all or a portion of a polypeptide of the invention. Monoclonal antibodies directed against the antigen can be obtained from the immunized, transgenic mice using conventional hybridoma technology. The human immunoglobulin transgenes harbored by the transgenic mice rearrange during B cell differentiation, and subsequently undergo class switching and somatic mutation. Thus, using such a technique, it is possible to produce therapeutically useful IgG, IgA, IgM and IgE antibodies. For an overview of this technology for producing human antibodies, see Lonberg and Huszar (1995, *Int. Rev. Immunol.* 13:65-93). For a detailed discussion of this technology for producing human antibodies and human monoclonal antibodies and protocols for producing such antibodies, *see, e.g.*, PCT publication Nos. WO 98/24893, WO 96/34096, and WO 96/33735; and U.S. Patent Nos. 5,413,923, 5,625,126, 5,633,425, 5,569,825, 5,661,016, 5,545,806, 5,814,318, and 5,939,598, which are incorporated by reference herein in their entirety. In addition, companies such as Abgenix, Inc. (Freemont, CA) and Genpharm (San Jose, CA) can be engaged to provide human antibodies directed against a selected antigen using technology similar to that described above.

A chimeric antibody is a molecule in which different portions of the antibody are derived from different immunoglobulin molecules such as antibodies having a variable region derived from a human antibody and a non-human immunoglobulin constant region. Methods for producing chimeric antibodies are known in the art. See *e.g.*, Morrison, 1985,

Science 229:1202; Oi et al., 1986, BioTechniques 4:214; Gillies et al., 1989, J. Immunol. Methods 125:191-202; and U.S. Patent Nos. 5,807,715, 4,816,567, and 4,8 16397, which are incorporated herein by reference in their entirety. Chimeric antibodies comprising one or more CDRs from human species and framework regions from a non-human immunoglobulin molecule can be produced using a variety of techniques known in the art including, for example, CDR-grafting (EP 239,400; PCT publication No. WO 91/09967; and U.S. Patent Nos. 5,225,539, 5,530,101, and 5,585,089), veneering or resurfacing (EP 592,106; EP 519,596; Padlan, 1991, Molecular Immunology 28(4/5):489-498; Studnicka et al., 1994, Protein Engineering 7(6):805-814; and Roguska et al., 1994, PNAS 91:969-973), and chain shuffling (U.S. Patent No. 5,565,332). In a preferred embodiment, chimeric antibodies comprise a human CDR3 having an amino acid sequence of any one of the CDR3 listed in Table 2 and non-human framework regions. Often, framework residues in the framework regions will be substituted with the corresponding residue from the CDR donor antibody to alter, preferably improve, antigen binding. These framework substitutions are identified by methods well known in the art, *e.g.*, by modeling of the interactions of the CDR and framework residues to identify framework residues important for antigen binding and sequence comparison to identify unusual framework residues at particular positions. (See, *e.g.*, Queen et al., U.S. Patent No. 5,585,089; and Riechmann et al., 1988, Nature 332:323, which are incorporated herein by reference in their entireties.)

Further, the antibodies of the invention can, in turn, be utilized to generate anti-idiotype antibodies that "mimic" RSV antigens using techniques well known to those skilled in the art. (See, *e.g.*, Greenspan & Bona, 1989, FASEB J. 7(5):437-444; and Nissinoff, 1991, J. Immunol. 147(8):2429-2438). For example, antibodies of the invention which bind to and competitively inhibit the binding of RSV (as determined by assays well known in the art and disclosed in *supra*) to its host cell receptor can be used to generate anti-idiotypes that "mimic" a RSV antigen binding domain and, as a consequence, bind to and neutralize RSV and/or its host cell receptor. Such neutralizing anti-idiotypes or Fab fragments of such anti-idiotypes can be used in therapeutic regimens to neutralize RSV. For example, such anti-idiotypic antibodies can be used to bind RSV and/or to bind its host cell receptors, and thereby block infection.

5.6.1. Polynucleotides Encoding an Antibody

The invention provides polynucleotides comprising a nucleotide sequence encoding an antibody of the invention or a fragment thereof. The invention also encompasses polynucleotides that hybridize under high stringency, intermediate or lower stringency

hybridization conditions, *e.g.*, as defined *supra*, to polynucleotides that encode an antibody of the invention.

The polynucleotides may be obtained, and the nucleotide sequence of the polynucleotides determined, by any method known in the art. Since the amino acid sequences of the antibodies are known (as described in Table 2), nucleotide sequences encoding these antibodies can be determined using methods well known in the art, *i.e.*, nucleotide codons known to encode particular amino acids are assembled in such a way to generate a nucleic acid that encodes the antibody or fragment thereof of the invention. Such a polynucleotide encoding the antibody may be assembled from chemically synthesized oligonucleotides (*e.g.*, as described in Kutmeier et al., 1994, BioTechniques 17:242), which, briefly, involves the synthesis of overlapping oligonucleotides containing portions of the sequence encoding the antibody, annealing and ligating of those oligonucleotides, and then amplification of the ligated oligonucleotides by PCR.

Alternatively, a polynucleotide encoding an antibody may be generated from nucleic acid from a suitable source. If a clone containing a nucleic acid encoding a particular antibody is not available, but the sequence of the antibody molecule is known, a nucleic acid encoding the immunoglobulin may be chemically synthesized or obtained from a suitable source (*e.g.*, an antibody cDNA library, or a cDNA library generated from, or nucleic acid, preferably poly A+ RNA, isolated from, any tissue or cells expressing the antibody, such as hybridoma cells selected to express an antibody of the invention) by PCR amplification using synthetic primers hybridizable to the 3' and *5* 'ends of the sequence or by cloning using an oligonucleotide probe specific for the particular gene sequence to identify, *e.g.*, a cDNA clone from a cDNA library that encodes the antibody. Amplified nucleic acids generated by PCR may then be cloned into replicable cloning vectors using any method well known in the art.

Once the nucleotide sequence of the antibody is determined, the nucleotide sequence of the antibody may be manipulated using methods well known in the art for the manipulation of nucleotide sequences, *e.g.*, recombinant DNA techniques, site directed mutagenesis, PCR, etc. (see, for example, the techniques described in Sambrook et al., 1990, Molecular Cloning, A Laboratory Manual, 2d Ed., Cold Spring Harbor Laboratory, Cold Spring Harbor, NY and Ausubel *et al.*, eds., 1998, Current Protocols in Molecular Biology, John Wiley & Sons, NY, which are both incorporated by reference herein in their entireties), to generate antibodies having a different amino acid sequence, for example to create amino acid substitutions, deletions, and/or insertions.

In a specific embodiment, one or more of the CDRs is inserted within framework regions using routine recombinant DNA techniques. The framework regions may be

naturally occurring or consensus framework regions, and preferably human framework regions (see, *e.g.*, Chothia et al., 1998, J. Mol. Biol. 278: 457-479 for a listing of human framework regions). Preferably, the polynucleotide generated by the combination of the framework regions and CDRs encodes an antibody that specifically binds to a RSV antigen. Preferably, as discussed *supra*, one or more amino acid substitutions may be made within the framework regions, and, preferably, the amino acid substitutions improve binding of the antibody to its antigen. Additionally, such methods may be used to make amino acid substitutions or deletions of one or more variable region cysteine residues participating in an intrachain disulfide bond to generate antibody molecules lacking one or more intrachain disulfide bonds. Other alterations to the polynucleotide are encompassed by the present invention and within the skill of the art.

5.6.2. Recombinant Expression of an Antibody

Recombinant expression of an antibody of the invention, derivative or analog thereof, (*e.g.*, a heavy or light chain of an antibody of the invention or a portion thereof or a single chain antibody of the invention), requires construction of an expression vector containing a polynucleotide that encodes the antibody. Once a polynucleotide encoding an antibody molecule or a heavy or light chain of an antibody, or portion thereof (preferably, but not necessarily, containing the heavy or light chain variable domain), of the invention has been obtained, the vector for the production of the antibody molecule may be produced by recombinant DNA technology using techniques well known in the art. Thus, methods for preparing a protein by expressing a polynucleotide containing an antibody encoding nucleotide sequence are described herein. Methods which are well known to those skilled in the art can be used to construct expression vectors containing antibody coding sequences and appropriate transcriptional and translational control signals. These methods include, for example, *in vitro* recombinant DNA techniques, synthetic techniques, and *in vivo* genetic recombination. The invention, thus, provides replicable vectors comprising a nucleotide sequence encoding an antibody molecule of the invention, a heavy or light chain of an antibody, a heavy or light chain variable domain of an antibody or a portion thereof, or a heavy or light chain CDR, operably linked to a promoter. Such vectors may include the nucleotide sequence encoding the constant region of the antibody molecule (see, e.g., PCT Publication WO 86/05807; PCT Publication WO 89/01036; and U.S. Patent No. 5,122,464) and the variable domain of the antibody may be cloned into such a vector for expression of the entire heavy, the entire light chain, or both the entire heavy and light chains.

The expression vector is transferred to a host cell by conventional techniques and the transfected cells are then cultured by conventional techniques to produce an antibody of

the invention. Thus, the invention includes host cells containing a polynucleotide encoding an antibody of the invention or fragments thereof, or a heavy or light chain thereof, or portion thereof, or a single chain antibody of the invention, operably linked to a heterologous promoter. In preferred embodiments for the expression of double-chained antibodies, vectors encoding both the heavy and light chains may be co-expressed in the host cell for expression of the entire immunoglobulin molecule, as detailed below.

A variety of host-expression vector systems may be utilized to express the antibody molecules of the invention (see, *e.g.*, U.S. Patent No. 5,807,715). Such host-expression systems represent vehicles by which the coding sequences of interest may be produced and subsequently purified, but also represent cells which may, when transformed or transfected with the appropriate nucleotide coding sequences, express an antibody molecule of the invention *in situ*. These include but are not limited to microorganisms such as bacteria (*e.g.*, *E. coli* and *B. subtilis*) transformed with recombinant bacteriophage DNA, plasmid DNA or cosmid DNA expression vectors containing antibody coding sequences; yeast (*e.g.*, *Saccharomyces Pichia*) transformed with recombinant yeast expression vectors containing antibody coding sequences; insect cell systems infected with recombinant virus expression vectors (*e.g.*, baculovirus) containing antibody coding sequences; plant cell systems infected with recombinant virus expression vectors (*e.g.*, cauliflower mosaic virus, CaMV; tobacco mosaic virus, TMV) or transformed with recombinant plasmid expression vectors (*e.g.*, Ti plasmid) containing antibody coding sequences; or mammalian cell systems (*e.g.*, COS, CHO, BHK, 293, NS0, and 3T3 cells) harboring recombinant expression constructs containing promoters derived from the genome of mammalian cells (*e.g.*, metallothionein promoter) or from mammalian viruses (*e.g.*, the adenovirus late promoter; the vaccinia virus 7.5K promoter). Preferably, bacterial cells such as *Escherichia coli*, and more preferably, eukaryotic cells, especially for the expression of whole recombinant antibody molecule, are used for the expression of a recombinant antibody molecule. For example, mammalian cells such as Chinese hamster ovary cells (CHO), in conjunction with a vector such as the major intermediate early gene promoter element from human cytomegalovirus is an effective expression system for antibodies (Foecking et al., 1986, Gene 45:101; and Cockett et al., 1990, Bio/Technology 8:2). In a specific embodiment, the expression of nucleotide sequences encoding antibodies or fragments thereof which immunospecifically bind to one or more RSV antigens is regulated by a constitutive promoter, inducible promoter or tissue specific promoter.

In bacterial systems, a number of expression vectors may be advantageously selected depending upon the use intended for the antibody molecule being expressed. For example, when a large quantity of such a protein is to be produced, for the generation of

pharmaceutical compositions of an antibody molecule, vectors which direct the expression of high levels of fusion protein products that are readily purified may be desirable. Such vectors include, but are not limited to, the *E. coli* expression vector pUR278 (Ruther et al., 1983, EMBO 12:1791), in which the antibody coding sequence may be ligated individually into the vector in frame with the lac Z coding region so that a fusion protein is produced; pIN vectors (Inouye & Inouye, 1985, Nucleic Acids Res. 13:3101-3109; Van Heeke & Schuster, 1989, J. Biol. Chem. 24:5503-5509); and the like. pGEX vectors may also be used to express foreign polypeptides as fusion proteins with glutathione 5-transferase (GST). In general, such fusion proteins are soluble and can easily be purified from lysed cells by adsorption and binding to matrix glutathione agarose beads followed by elution in the presence of free glutathione. The pGEX vectors are designed to include thrombin or factor Xa protease cleavage sites so that the cloned target gene product can be released from the GST moiety.

In an insect system, Autographa californica nuclear polyhedrosis virus (AcNPV) is used as a vector to express foreign genes. The virus grows in *Spodoptera frugiperda* cells. The antibody coding sequence may be cloned individually into non-essential regions (for example the polyhedrin gene) of the virus and placed under control of an AcNPV promoter (for example the polyhedrin promoter).

In mammalian host cells, a number of viral-based expression systems may be utilized. In cases where an adenovirus is used as an expression vector, the antibody coding sequence of interest may be ligated to an adenovirus transcription/translation control complex, *e.g.*, the late promoter and tripartite leader sequence. This chimeric gene may then be inserted in the adenovirus genome by *in vitro* or *in vivo* recombination. Insertion in a non-essential region of the viral genome (*e.g.*, region El or E3) will result in a recombinant virus that is viable and capable of expressing the antibody molecule in infected hosts (*e.g.*, see Logan & Shenk, 1984, Proc. Natl. Acad. Sci. USA 8 1:355-359). Specific initiation signals may also be required for efficient translation of inserted antibody coding sequences. These signals include the ATG initiation codon and adjacent sequences. Furthermore, the initiation codon must be in phase with the reading frame of the desired coding sequence to ensure translation of the entire insert. These exogenous translational control signals and initiation codons can be of a variety of origins, both natural and synthetic. The efficiency of expression may be enhanced by the inclusion of appropriate transcription enhancer elements, transcription terminators, etc. (see, *e.g.*, Bittner et al., 1987, Methods in Enzymol. 153:51-544).

In addition, a host cell strain may be chosen which modulates the expression of the inserted sequences, or modifies and processes the gene product in the specific fashion

desired. Such modifications (*e.g.*, glycosylation) and processing (*e.g.*, cleavage) of protein products may be important for the function of the protein. Different host cells have characteristic and specific mechanisms for the post-translational processing and modification of proteins and gene products. Appropriate cell lines or host systems can be chosen to ensure the correct modification and processing of the foreign protein expressed. To this end, eukaryotic host cells which possess the cellular machinery for proper processing of the primary transcript, glycosylation, and phosphorylation of the gene product may be used. Such mammalian host cells include but are not limited to CHO, VERY, BHK, Hela, COS, MDCK, 293, 3T3, W138, BT483, Hs578T, HTB2, BT2O and T47D, NS0 (a murine myeloma cell line that does not endogenously produce any immunoglobulin chains), CRL7O3O and HsS78Bst cells.

For long-term, high-yield production of recombinant proteins, stable expression is preferred. For example, cell lines which stably express the antibody molecule may be engineered. Rather than using expression vectors which contain viral origins of replication, host cells can be transformed with DNA controlled by appropriate expression control elements (*e.g.*, promoter, enhancer, sequences, transcription terminators, polyadenylation sites, etc.), and a selectable marker. Following the introduction of the foreign DNA, engineered cells may be allowed to grow for 1-2 days in an enriched media, and then are switched to a selective media. The selectable marker in the recombinant plasmid confers resistance to the selection and allows cells to stably integrate the plasmid into their chromosomes and grow to form foci which in turn can be cloned and expanded into cell lines. This method may advantageously be used to engineer cell lines which express the antibody molecule. Such engineered cell lines may be particularly useful in screening and evaluation of compositions that interact directly or indirectly with the antibody molecule.

A number of selection systems may be used, including but not limited to, the herpes simplex virus thymidine kinase (Wigler et al., 1977, Cell 11:223), hypoxanthineguanine phosphoribosyltransferase (Szybalska & Szybalski, 1992, Proc. Natl. Acad. Sci. USA 48:202), and adenine phosphoribosyltransferase (Lowy et al., 1980, Cell 22:8-17) genes can be employed in tk-, hgprt- or aprt- cells, respectively. Also, antimetabolite resistance can be used as the basis of selection for the following genes: *dhfr*, which confers resistance to methotrexate (Wigler et al., 1980, Natl. Acad. Sci. USA 77:357; O'Hare et al., 1981, Proc. Natl. Acad. Sci. USA 78:1527); *gpt*, which confers resistance to mycophenolic acid (Mulligan & Berg, 1981, Proc. Natl. Acad. Sci. USA 78:2072); neo, which confers resistance to the aminoglycoside G-418 (Wu and Wu, 1991, Biotherapy 3:87-95; Tolstoshev, 1993, Ann. Rev. Pharmacol. Toxicol. 32:573-596; Mulligan, 1993, Science 260:926-932; and Morgan and Anderson, 1993, Ann. Rev. Biochem. 62: 191-217; May,

1993, TIB TECH 11(5):155-2 15); and *hygro*, which confers resistance to hygromycin (Santerre et al., 1984, Gene 30:147). Methods commonly known in the art of recombinant DNA technology may be routinely applied to select the desired recombinant clone, and such methods are described, for example, in Ausubel *et al.* (eds.), Current Protocols in Molecular Biology, John Wiley & Sons, NY (1993); Kriegler, Gene Transfer and Expression, A Laboratory Manual, Stockton Press, NY (1990); and in Chapters 12 and 13, Dracopoli *et al.* (eds), Current Protocols in Human Genetics, John Wiley & Sons, NY (1994); Colberre-Garapin et al., 1981, J. Mol. Biol. 150:1, which are incorporated by reference herein in their entireties.

The expression levels of an antibody molecule can be increased by vector amplification (for a review, see Bebbington and Hentschel, The use of vectors based on gene amplification for the expression of cloned genes in mammalian cells in DNA cloning, Vol.3. (Academic Press, New York, 1987)). When a marker in the vector system expressing antibody is amplifiable, increase in the level of inhibitor present in culture of host cell will increase the number of copies of the marker gene. Since the amplified region is associated with the antibody gene, production of the antibody will also increase (Crouse et al., 1983, Mol. Cell. Biol. 3:257).

The host cell may be co-transfected with two expression vectors of the invention, the first vector encoding a heavy chain derived polypeptide and the second vector encoding a light chain derived polypeptide. The two vectors may contain identical selectable markers which enable equal expression of heavy and light chain polypeptides. Alternatively, a single vector may be used which encodes, and is capable of expressing, both heavy and light chain polypeptides. In such situations, the light chain should be placed before the heavy chain to avoid an excess of toxic free heavy chain (Proudfoot, 1986, Nature 322:52; and Kohler, 1980, Proc. Natl. Acad. Sci. USA 77:2 197). The coding sequences for the heavy and light chains may comprise cDNA or genomic DNA.

Once an antibody molecule of the invention has been produced by recombinant expression, it may be purified by any method known in the art for purification of an immunoglobulin molecule, for example, by chromatography (*e.g.*, ion exchange, affinity, particularly by affinity for the specific antigen after Protein A, and sizing column chromatography), centrifugation, differential solubility, or by any other standard technique for the purification of proteins. Further, the antibodies of the present invention or fragments thereof may be fused to heterologous polypeptide sequences described herein or otherwise known in the art to facilitate purification.

5.7. Kits

The invention also provides a pharmaceutical pack or kit comprising one or more containers filled with one or more of the ingredients of the pharmaceutical compositions of the invention. Optionally associated with such container(s) can be a notice in the form prescribed by a governmental agency regulating the manufacture, use or sale of pharmaceuticals or biological products, which notice reflects approval by the agency of manufacture, use or sale for human administration.

The present invention provides kits that can be used in the above methods. In one embodiment, a kit comprises an antibody of the invention, preferably a purified antibody, in one or more containers. In an alterative embodiment, a kit comprises an antibody fragment that immunospecifically binds to a RSV antigen. In a specific embodiment, the kits of the present invention contain a substantially isolated RSV antigen as a control. Preferably, the kits of the present invention further comprise a control antibody which does not react with the RSV antigen. In another specific embodiment, the kits of the present invention contain a means for detecting the binding of an antibody to a RSV antigen (*e.g.*, the antibody may be conjugated to a detectable substrate such as a fluorescent compound, an enzymatic substrate, a radioactive compound or a luminescent compound, or a second antibody which recognizes the first antibody may be conjugated to a detectable substrate). In specific embodiments, the kit may include a recombinantly produced or chemically synthesized RSV antigen. The RSV antigen provided in the kit may also be attached to a solid support. In a more specific embodiment the detecting means of the above-described kit includes a solid support to which RSV antigen is attached. Such a kit may also include a non-attached reporter-labeled anti-human antibody. In this embodiment, binding of the antibody to the RSV antigen can be detected by binding of the said reporter-labeled antibody.

In an additional embodiment, the invention includes a diagnostic kit for use in screening serum containing RSV antigens. The diagnostic kit includes a substantially isolated antibody specifically immunoreactive with a RSV antigen, and means for detecting the binding of the RSV antigen to the antibody. In one embodiment, the antibody is attached to a solid support. In a specific embodiment, the antibody may be a monoclonal antibody. The detecting means of the kit may include a second, labeled monoclonal antibody. Alternatively, or in addition, the detecting means may include a labeled, competing antigen.

In one diagnostic configuration, test serum is reacted with a solid phase reagent having a surface-bound RSV antigen obtained by the methods of the present invention. After the RSV antigen binds to a specific antibody, the unbound serum components are removed by washing, reporter-labeled anti-human antibody is added, unbound anti-human

antibody is removed by washing, and a reagent is reacted with reporter-labeled anti-human antibody to bind reporter to the reagent in proportion to the amount of bound anti-RSV antigen antibody on the solid support. Typically, the reporter is an enzyme which is detected by incubating the solid phase in the presence of a suitable fluorometric, luminescent or colorimetric substrate (Sigma, St. Louis, MO).

The solid surface reagent in the above assay is prepared by known techniques for attaching protein material to solid support material, such as polymeric beads, dip sticks, 96-well plate or filter material. These attachment methods generally include non-specific adsorption of the protein to the support or covalent attachment of the protein, typically through a free amine group, to a chemically reactive group on the solid support, such as an activated carboxyl, hydroxyl, or aldehyde group. Alternatively, streptavidin coated plates can be used in conjunction with biotinylated antigen(s).

Thus, the invention provides an assay system or kit for carrying out this diagnostic method. The kit generally includes a support with surface-bound recombinant RSV antigen, and a reporter-labeled anti-human antibody for detecting surface-bound anti-RSV antigen antibody.

6. EXAMPLE: KINETIC ANALYSIS OF HUMANIZED RSV MABS BY BIACORE™

A typical kinetic study involved the injection of 250 µl of monoclonal antibody ("Mab") at varying concentrations (25-300 nM) in PBS buffer containing 0.05% Tween-20 (PBS/Tween). The flow rate was maintained at 75 µl/min, giving a 15 minute dissociation time. Following the injection of Mab, the flow was exchanged with PBS/Tween buffer for 30 min for determining the rate of dissociation. The sensor chip was regenerated between cycles with a 1 min pulse of 100 mM HCl. The regeneration step caused a minimal loss of binding capacity of the immobilized F-protein (4% loss per cycle). This small decrease did not change the calculated values of the rate constants for binding and dissociation (also called the k_{on} and k_{off}, respectively).

More specifically, for measurement of k_{assoc} (or k_{on}), F protein was directly immobilized by the EDC/NHS method (EDC = N-ethyl-N'-[3-diethylaminopropyl)-carbodiimide). Briefly, 25 mg/ml of F protein in 10 mM NaoAc, pH 5.0 was prepared and about a 5-10 µl injection gives about 30-50 RU (response units) of immobilized F protein under the above referenced conditions. The blank was subtracted for kinetic analysis. The column could be regenerated using 100 mM HCl (with 60 seconds of contact time being required for full regeneration). This treatment removed bound Fab completely without damaging the immobilized antigen and could be used for over 40 regenerations. For k_{on}

measurements, Fab concentrations were 0.39 nM, .75 nM, 1.56 nM, 3.13 nM, 12.5 nM, 25 nM, 50 nM, and 100 nM. The dissociation phase was analyzed for approximately 900 seconds. Kinetics were analyzed by 1:1 Langmuir fitting (global fitting). Measurements were done in HBS-EP buffer (10 mM HEPES, pH 7.4, 150 mM NaCl, 3 mM EDTA, 0.005% (v/v) Surfactant P20.

For measurements of combinatorial clones, as disclosed herein, the k_{on} and k_{off} were measured separately. The k_{on} was measured at conditions that were the same as those for the single mutation clones and was analyzed similarly.

For measuring k_{off}, the following conditions were employed. Briefly, 4100 RU of F protein were immobilized (as above) with CM-dextran used as the blank. Here, 3000 RU of Fab was bound (with dissociated Fab high enough to offset machine fluctuation). HBS plus 5 nM F protein (about 350 – 2000 times higher than the K_d – the dissociation equilibrium constant) was used as buffer. The dissociation phase was 6 – 15 hours at a flow rate of 5 ml/min. Under the conditions used herein, re-binding of the dissociated Fab was minimal. For further details, see the manual with the biosensor.

The binding of the high affinity anti-RSV antibodies to the F protein, or other epitopic sites on RSV, disclosed herein was calculated from the ratio of the first order rate constant for dissociation to the second order rate constant for binding or association ($K_d = k_{off}/k_{on}$). The value for k_{on} was calculated based on the following rate equation:

$$dR/dt = k_{on}[Mab]R_{max} - (k_{on}[Mab]+k_{off})R$$

where R and R_{max} are the response units at time t and infinity, respectively. A plot of dr/dt as a function of R gives a slope of (k_a [Mab]+k_d)--since these slopes are linearly related to the [Mab], the value k_{on} can be derived from a replot of the slopes versus [Mab]. The slope of the new line is equal to k_{on}. Although the value of k_{off} can be extrapolated from the Y-intercept, a more accurate value was determined by direct measurement of k_{off}. Following the injection phase of the Mab, PBS/Tween buffer flows across the sensor chip. From this point, [Mab]=0. The above stated equation for dR/dt thus reduces to:

$$dr/dt = k \qquad \text{or} \qquad dR/R = k_{off}\, dt$$

Integration of this equation then gives:

$$\ln(R_0/R_t) = k_{off}\, t$$

where R_0 /R_t) are the response units at time 0 (start of dissociation phase) and t, respectively. Lastly, plotting In(R_0 /R_t) as a function of t gives a slope of k_{off}.

The numerical values from such antibody variants were as shown in Tables 4-7 below.

Table 4. Summary of Kinetic Constants for High Potency Antibodies.

SEQ ID NO.	K_{on} x 10^5 ($M^{-1}s^{-1}$)	K_{off} x 10^{-4} (s^{-1})	EC_{50} (nM)
7	2.04; 1.89; 2.18	7.64; 7.38; 7.02	3.57
10	1.08; 0.96; 1.24	2.74; 2.66; 2.06	
18	1.85	6.5	
20	4.59; 4.67; 5.72; 6.25; 5.33	4.45; 4.02	
24	6.05	3.38	
27	7.57	4.62	
30	2.65; 2.83; 4.16; 3.18; 2.88	1.67; 4.44	
33	2.12; 1.56; 1.86	2.45; 4.46; 2.68	
34	3.14; 4.44	1.78; 4.73	
36	3.29; 3.57; 4.05; 3.35; 4.26	1.92; 3.31; 2.29	
39	3.69; 2.82; 3.12; 5.33; 3.78	1.34; 4.16; 2.70	
42	6.63	2.82	0.65
50	5.27	2.99	0.70
55	5.70; 5.72	7.17	>20
60	7.9	4.53	2.5
64	7.43	2.30	0.62
69	7.35	2.50	2.04
73	7.81; 7.35	2.80	0.52

Table 5.

Monoclonal Antibodies vs Bac-F (1:1)

	***Kon* (x E+5)**	***Koff* (x E-5)**	**KD (nM)**	**Chi2**
P12f2 (SEQ ID NO:78)	4.07	12.8	0.31 (13)	0.9
P12f4 (SEQ ID NO:79)	4.95	5.55	0.11 (35)	0.6
A13c4 (SEQ ID NO:83)	3.00	3.96	0.13 (30)	1.2
A12a6 (SEQ ID NO:82)	4.60	1.65	0.04 (98)	1.2
A1e9 (SEQ ID NO:81)	4.33	14.3	0.33 (12)	2.5
A8c7 (SEQ ID NO:92)	4.17	8.75	0.21 (19)	1.8
P11d4 (SEQ ID NO:80)	4.66	28.9	0.62 (6)	1.0
A17d4 (SEQ ID NO:84)	4.56	4.07	0.09 (43)	0.5
A4b4 (SEQ ID NO:88)	4.34	1.06	0.02 (195)	1.5
SYNAGIS® (SEQ ID NO:7)	1.32	51.5	3.90 (1)	0.6

Table 6.

Monoclonal Antibodies vs NUF4 (1:1)

	Kon (x E+5)	Koff (x E-5)	KD (nM)	Chi2
P12f2	5.41	17.8	0.33 (26)	1.2
P12f4	9.43	22.9	0.24 (36)	0.9
A13c4	3.65	27.2	0.75 (12)	1.8
A12a6	4.00	29.1	0.73 (12)	1.9
A1e9	8.43	58.4	0.69 (13)	0.9
A8c7	8.25	53.5	0.65 (13)	0.7
P11d4	9.04	76.6	0.85 (10)	2.5
A17d4	4.99	36.2	0.73 (12)	2.0
A4b4	4.96	28.2	0.57 (15)	1.9
SYNAGIS®	3.04	265	8.70 (1)	0.4

Table 7.

Monoclonal Antibodies vs NUF4 (2:1)

	Kon (x E+5)	Koff (x E-5)	KD (nM)	Chi2
P12f2	2.82	23.6	0.84 (371)	1.5
P12f4	2.73	63.6	2.33 (134)	4.9
A13c4	3.20	22.5	0.70 (446)	1.7
A12a6	2.18	40.8	1.87 (167)	1.9
A1e9	3.29	139	4.22 (74)	2.8
A8c7	4.30	114	2.65 (118)	2.0
P11d4	3.66	313	8.55 (36)	3.6
A17d4	2.64	29.2	1.11 (281)	1.7
A4b4	2.03	40.06	2.00 (156)	1.4
SYNAGIS®	0.78	2420	312 (1)	1.3

SEQ ID NO:18, SEQ ID NO:20, SEQ ID NO:24, SEQ ID NO:27, SEQ ID NO:30, SEQ ID NO:33, SEQ ID NO:34, SEQ ID NO:36, SEQ ID NO:39, SEQ ID NO:42, SEQ ID

NO:50, SEQ ID NO:55, SEQ ID NO:60, SEQ ID NO:64, SEQ ID NO:69 and SEQ ID NO:73 are Fab fragments having the framework sequences of Figure 1 and the indicated CDR sequences indicated listed in Table 2. SEQ ID NOs. 7 and 10 are actual monoclonal antibodies with the framework sequences of Figure 1 and constant regions as described in Johnson et al. (1997, Journal of Infectious Diseases 176:1215-1224) and U.S. Patent No. 5,824,307. The framework sequences of these antibodies may differ slightly from those of the Fab fragments.

The amino acid sequences of the indicated CDRs in Table 1 represent the amino acid residues located at the key locations within the CDRs of the high potency antibodies produced by the methods described herein and in copending applications Serial Nos. 60/168,426 and 60/186,252. For example, to increase the potency of an antibody by producing a higher k_{on} value, the amino acids located at the key positions as taught herein by the bold and underlined residues in Table 1 for the reference antibody would be replaced by the amino acids listed under CDRs in Table 2 (and also bold and underlined). Thus, these one letter codes represent the amino acids replacing the reference amino acids at the key positions (or critical positions) of the CDRs shown in Figure 2 (residues in bold in the sequences of Table 2) for a reference antibody whose potency is to be increased.

7. EXAMPLE: MICRONEUTRALIZATION ASSAY

Neutralization of the antibodies of the present invention were determined by microneutralization assay. This microneutralization assay is a modification of the procedures described by Anderson et al. (1985, J. Clin. Microbiol. 22:1050-1052, the disclosure of which is hereby incorporated by reference in its entirety). The procedure used here is described in Johnson et al., 1999, J. Infectious Diseases 180:35-40, the disclosure of which is hereby incorporated by reference in its entirety. Antibody dilutions were made in triplicate using a 96-well plate. Ten $TCID_{50}$ of respiratory syncytial virus (RSV – Long strain) were incubated with serial dilutions of the antibody (or Fabs) to be tested for 2 hours at 37°C in the wells of a 96-well plate. RSV susceptible HEp-2 cells (2.5×10^4) were then added to each well and cultured for 5 days at 37°C in 5% CO_2. After 5 days, the medium was aspirated and cells were washed and fixed to the plates with 80% methanol and 20% PBS. RSV replication was then determined by F protein expression. Fixed cells were incubated with a biotin-conjugated anti-F protein monoclonal antibody (pan F protein, C-site-specific MAb 133-1H) washed and horseradish peroxidase conjugated avidin was added to the wells. The wells were washed again and turnover of substrate TMB (thionitrobenzoic acid) was measured at 450 nm. The neutralizing titer was expressed as the antibody concentration that caused at least 50% reduction in absorbency at 450 nm (the

OD_{450}) from virus-only control cells. The results from the assay for the monoclonal antibodies and Fab fragments listed in Table 2 are shown in Table 4 *supra* and Table 8 *infra*.

Table 8. End Point RSV Microneutralization Titer Of High On Rate Mutant IgG and Fab

Molecule	Mean IC50 (Curve) µg/ml	STDEV Curve IC50	Fold Difference (Curve ICX50)	Mean IC50 (Control) µg/ml	STDEV Control IC50	Fold Difference (Control IC50)	n (assay repeat)
Synagis (SEQ ID NO:7)	0.4527	0.208	-	0.5351	0.238	-	8
**A1e9 (SEQ ID NO:81)	0.0625	0.0268	7	0.0645	0.0223	8	3
**A17d4 (SEQ ID NO:84)	0.0342	0.022	13	0.0354	0.0187	15	4
**P11d4 (SEQ ID NO:80)	0.0217	0.0331	21	0.0289	0.0110	19	5
**P12f2 (SEQ ID NO:78)	0.0231	0.0141	20	0.0223	0.0083	24	6
**A8c7 (SEQ ID NO:92)	0.0337	0.0309	13	0.0383	0.0283	14	5
**A12a6 (SEQ ID NO:82)	0.0357	0.0316	13	0.0354	0.0261	15	7
**P12f4 (SEQ ID NO:79)	0.0242	0.0163	19	0.0235	0.0076	23	7
**A13c4 (SEQ ID NO:83)	0.0376	0.0268	12	0.0375	0.0213	14	6
**A4b4 (SEQ ID NO:88)	0.0171	0.0018	27	0.0154	0.00417	35	2

*A1e9 (SEQ ID NO:60)	0.157	-	3	0.125	-	4	1
*A17d4 (SEQ ID NO:222)	0.0179	-	25	0.0171	-	31	1
*P11d4 (SEQ ID NO:55)	>1.00	-	-	>1.00	-	-	1
*P12f2 (SEQ ID NO:42)	0.0407	0.0112	11	0.0326	0.00905	16	2
*A8c7 (SEQ ID NO:223)	0.177	-	3	0.157	-	34	1
*A12a6 (SEQ ID NO:64)	0.0287	0.00417	16	0.0310	0.00982	17	2
*P12f4 (SEQ ID NO:50)	0.0464	0.00791	10	0.0351	0.0126	15	2
*A13c4 (SEQ ID NO:73)	0.0264	0.00141	17	0.0258	0.00071	21	2
*A4b4 (SEQ ID NO:137)	0.0414	-	11	0.0411	-	13	1
*A13a11 (SEQ ID NO:69)	0.120	0.0222	4	0.1022	0.0260	5	2
*A1h5 (SEQ ID NO:225)	0.194	0.462	2	0.176	0.0625	3	2

** Monoclonal Antibody

* Fab Fragment

8. EXAMPLE: RSV FUSION INHIBITION ASSAY

The ability of the antibodies of the invention or fragments thereof to block RSV-induced fusion after viral attachment to the cells is determined in a fusion inhibition assay. This assay is identical to the microneutralization assay, except that the cells were infected

with RSV (Long) for four hours prior to addition of antibody (Taylor et al,1992, J. Gen. Virol. 73:2217-2223).

9. EXAMPLE: ISOTHERMAL TITRATION CALORIMETRY

Thermodynamic binding affinities and enthalpies were determined from isothermal titration calorimetry (ITC) measurements on the interaction of antibodies with RSV F glycoprotein (NUF4), an antigen which mimics the binding site of the RSV virus.

Methods & Materials

Antibodies & Antigen

Antibodies having the amino acid sequence of SEQ ID NO:83 (A13c4), SEQ ID NO:84 (A17d4), SEQ ID NO:88 (A4B4), and SEQ ID NO:7 (SYNAGIS®) were diluted in dialysate and the concentrations were determined by UV spectroscopic absorption measurements with a Perkin-Elmer Lambda 4B Spectrophotometer using an extinction coefficient of 217,000 M^{-1} cm^{-1} at the peak maximum at 280 nm. The diluted NUF4 concentrations were calculated from the ratio of the mass of the original sample to that of the diluted sample since its extinction coefficient was too low to determine an accurate concentration without employing and losing a large amount of sample.

ITC Measurements

The binding thermodynamics of the antibodies were determined from ITC measurements using a Microcal, Inc. VP Titration Calorimeter. The VP titration calorimeter consists of a matched pair of sample and reference vessels (1.409 ml) enclosed in an adiabatic enclosure and a rotating stirrer-syringe for titrating ligand solutions into the sample vessel. The ITC measurements were performed at 25°C and 35°C. The sample vessel contained the antibody in the phosphate buffer while the reference vessel contained just the buffer solution. The phosphate buffer solution was saline 67 mM PO_4 at pH 7.4 from HyClone, Inc. Five or ten µl aliquots of the 0.05 to 0.1 mM NUF4 solution were titrated 3 to 4 minutes apart into the antibody sample solution until the binding was saturated as evident by the lack of a heat exchange signal. With some antibody sample solutions, additional constant amounts of heat with the addition of each aliquot were observed following binding saturation of the antibody. This was attributed to a heat of dilution of the NUF4 titrant and was subtracted from the titrant heats obtained during the titration prior to analysis of the data.

A non-linear, least square minimization software program from Microcal, Inc., Origin 5.0, was used to fit the incremental heat of the ith titration (ΔQ (i)) of the total heat, Q_t, to the total titrant concentration, X_t, according to the following equations (I),

$$Q_t = nC_t\Delta H_b^{\circ}V\{1 + X_t/nC_t + 1/nK_bC_t - [(1 + X_t/nC_t + 1/nK_bC_t)^2 - 4X_t/nC_t]^{1/2}\}/2 \quad (1\ a)$$

$$\Delta Q(i) = Q(i) + dVi/2V\ \{Q(i) + Q(i-1)\} - Q(i-1) \quad (1b)$$

where C_t is the initial antibody concentration in the sample vessel, V is the volume of the sample vessel, and n is the stoichiometry of the binding reaction, to yield values of K_b, ΔH_b°, and n. The optimum range of sample concentrations for the determination of K_b depends on the value of K_b and is defined by the following relationship.

$$C_t\ K_b\ n \leq 500 \quad (2)$$

so that at 1 μM the maximum K_b that can be determined is less than $2.5 \times 10^8\ M^{-1}$. If the first titrant addition did not fit the binding isotherm, it was neglected in the final analysis since it may reflect release of an air bubble at the syringe opening-solution interface.

Results

The ITC results are summarized in Table 9. The higher than 2 stoichiometries in Table 9 indicate that either the concentration determination of the antibody or NUF4 was incorrect. Since the same NUF4 sample was used as a titrant with antibodies having the amino acid sequence of A13c4 at 35°C and A17d4 at 35°C, which exhibit in at least one of the titrations the correct stoichiometry of 2, it is assumed that the titrant concentration was correct and that the large values of n result from incorrectly determined antibody concentrations. However, it can be shown that the binding constants are critically dependent on the titrant concentration and, thus, despite the 2-3 disparity in n, the binding constants are correct. Since the binding constants of antibodies having the amino acid sequence of A4B4 and A13c4 at 25°C were near the upper determination limit by ITC (equation 2) and with the limited amount of available NUF4, it was decided to use 35°C as the reference temperature for comprising the binding affinities. The results summarized in Table 9 show that the binding affinities to NUF4 are in the order A4B4 > A13c4 > A17d4 > SYNAGIS®.

Table 9. Average Binding Constants and Enthalpies of NUF4 to Antibodies

Antibody	K_b	ΔH_b in kJ mol^{-1}
A4B4	269 ± 74 X 10^6 M^{-1} or ~3.7 nM*	92.8 ± 1.0
A13c4	107 ± 28 X 10^6 M^{-1} or 9 nM	67 ± 17
A17d4	75 ± 14 X 10^6 M^{-1} or 13 nM	68 ± 10
SYNAGIS®	1.23 ± 0.17 X 10^6 M^{-1} or 810 nM	71 ± 5

* Based only on the best titration run at 35°C.

4.0 nM is ITC lower limit of $1/K_b$ range (ITC range is limited to $[antibody]_n K_b = 500$ where n is the stoichiometry and [antibody] is the concentration of the antibody in the cell).

10. EXAMPLE: COTTON RAT PROPHYLAXIS

To determine the ability of SYNAGIS® to prevent lower respiratory tract RSV infection in cotton rats when administered by and intravenous (IV) route and to correlate the serum concentration of SYNAGIS® with a reduction in lung RSV titer.

Materials & Methods

SYNAGIS® lot L94H048 was used for studies III-47 and III-47A. SYNAGIS® lot L95 K016 was used for study III-58. Bovine serum albumin (BSA) (fraction V, Sigma Chemicals). RSV-Long (A subtype) was propagated in Hep-2 cells.

On day 0, to groups of cotton rats (*Sigmodon hispidis*, average weight 100 g) were administered SYNAGIS®, RSV-IGIV or BSA was administered by intramuscular injection. Twenty-four hours post administration, the animals were bled and infected intranasally with 10^5 pfu of RSV. Twenty-four hours later, the animals were bled and infected intranasally with 10^5 PFU or RSV (Long Strain). Four days after the infection, animals were sacrificed, and their lung tissue was harvested and pulmonary virus titers were determined by plaque titration. For studies III-47 and III-47A, the doses of monoclonal antibody ("MAb") consisted of 0.31, 0.63, 1.25, 2.5, 5.5 and 10 mg/kg (body weight). For studies III-58, the doses of MAb consisted of 0.63, 1.25, 2.5, 5.5 and 10 mg/kg (body weight). In all three studies bovine serum albumin (BSA) 10 mg/kg was used as a negative control. Human antibody concentrations in the serum at the time of challenge are determined using a sandwich ELISA.

Results

The results of the individual experiments are presented in Tables 10-12. The results of all of the experiments combined is shown in Table 13. All three studies show a significant reduction of pulmonary virus titers in animals treated with SYNAGIS®. A clear

dose-response effect was observed in the animals. The combined data indicated that a dose of 2.5 mg/kg results in a greater than 99% reduction in lung RSV titer. The mean serum concentration of SYNAGIS® for this dose at the time of viral challenge was 28.6 μg/ml.

Table 10. EXPERIMENT III-47

Compound	Number of Animals	Dose	Mean±Std Error Concentration of Human IgG (μg/ml)	Lung Viral Titer Geometric Mean ±Std Error (log10 pfu/gm)
BSA	4		0	$1.4x10^5±1.7$
SYNAGIS®	3	0.312mg/kg	3.83±1.1	$2.1x10^4±2.1$
SYNAGIS®	3	0.625mg/kg	5.27±0.37	$7.7x10^4±1.6$
SYNAGIS®	4	1.25mg/kg	9.15±0.16	$3.4x10^4±1.3$
SYNAGIS®	3	2.50mg/kg	23.4±2.8	$1.4x10^3±1.7$
SYNAGIS®	2	5.0mg/kg	42.4±13.4	$4.6x10^2±4.6$
SYNAGIS®	4	10.0mg/kg	141.1±14.4	$1.0x10^2±1.0$

Table 11. EXPERIMENT III-47A

Compound	Number of Animals	Dose	Mean±Std Error Concentration of Human IgG (μg/ml)	Lung Viral Titer Geometric Mean ±Std Error (log10 pfu/gm)
BSA	4		0	$1.9x10^5±1.2$
SYNAGIS®	4	0.312mg/kg	1.8±0.12	$8.5x10^4±1.2$
SYNAGIS®	4	0.625mg/kg	4.0±0.19	$5.0x10^4±1.6$
SYNAGIS®	4	1.25mg/kg	11.8±0.68	$1.9x10^3±1.4$
SYNAGIS®	4	2.50mg/kg	18.9±2.0	$5.3x10^3±1.6$
SYNAGIS®	3	5.0mg/kg	55.6±2.3	$1.6x10^2±1.3$
SYNAGIS®	4	10.0mg/kg	109.7±5.22	$1.0x10^2±1.0$

Table 12. EXPERIMENT III-58

Compound	Number of Animals	Dose	Mean±Std Error Concentration of Human IgG (μg/ml)	Lung Viral Titer Geometric Mean ±Std Error (log10 pfu/gm)
BSA	4		0	$1.1x10^5±1.2$
SYNAGIS®	4	0.625mg/kg	5.78±0.32	$1.6x10^4±1.2$
SYNAGIS®	4	1.25mg/kg	9.82±0.23	$1.6x10^3±1.3$
SYNAGIS®	4	2.50mg/kg	34.1±2.11	$4.3x10^2±1.6$
SYNAGIS®	3	5.0mg/kg	58.3±4.48	$1.0x10^2±1.0$
SYNAGIS®	4	10.0mg/kg	111.5±5.04	$1.0x10^2±1.0$

Table 13. III-47, III-47A and III-58 COMBINED

Compound	Number of Animals	Dose	Mean±Std Error Concentration of Human IgG (μg/ml)	Lung Viral Titer Geometric Mean ±Std Error (log10 pfu/gm)
BSA	18		0	$1.3x10^5$±1.2
SYNAGIS®	7	0.312mg/kg	2.67±0.60	$4.6x10^4$±1.5
SYNAGIS®	17	0.625mg/kg	5.27±0.27	$2.7x10^4$±1.3
SYNAGIS®	18	1.25mg/kg	10.1±0.29	$3.3x10^3$±1.4
SYNAGIS®	17	2.50mg/kg	28.6±2.15	$9.6x10^2$±1.5
SYNAGIS®	15	5.0mg/kg	55.6±3.43	$1.3x10^2$±1.2
SYNAGIS®	18	10.0mg/kg	117.6±5.09	$1.0x10^2$±1.0

11. EXAMPLE: CLINICAL TRIALS

Antibodies of the invention or fragments thereof tested in *in vitro* assays and animal models may be further evaluated for safety, tolerance and pharmacokinetics in groups of normal healthy adult volunteers. The volunteers are administered intramuscularly, intravenously or by a pulmonary delivery system a single dose of 0.5 mg/kg, 3 mg/kg, 5 mg/kg, 10 mg/kg or 15 mg/kg of an antibody or fragment thereof which immunospecifically binds to a RSV antigen. Each volunteer is monitored at least 24 hours prior to receiving the single dose of the antibody or fragment thereof and each volunteer will be monitored for at least 48 hours after receiving the dose at a clinical site. Then volunteers are monitored as outpatients on days 3, 7, 14, 21, 28, 35, 42, 49, and 56 postdose.

Blood samples are collected via an indwelling catheter or direct venipuncture using 10 ml red-top Vacutainer tubes at the following intervals: (1) prior to administering the dose of the antibody or antibody fragment; (2) during the administration of the dose of the antibody or antibody fragment; (3) 5 minutes, 10 minutes, 15 minutes, 20 minutes, 30 minutes, 1 hour, 2 hours, 4 hours, 8 hours, 12 hours, 24 hours, and 48 hours after administering the dose of the antibody or antibody fragment; and (4) 3 days, 7 days 14 days, 21 days, 28 days, 35 days, 42 days, 49 days, and 56 days after administering the dose of the antibody or antibody fragment. Samples are allowed to clot at room temperature and serum will be collected after centrifugation.

The antibody or antibody fragment is partially purified from the serum samples and the amount of antibody or antibody fragment in the samples will be quantitated by ELISA. Briefly, the ELISA consists of coating microtiter plates overnight at 4°C with an antibody that recognizes the antibody or antibody fragment administered to the volunteer. The plates are then blocked for approximately 30 minutes at room temperate with PBS-Tween-0.5% BSA. Standard curves are constructed using purified antibody or antibody fragment, not administered to a volunteer. Samples are diluted in PBS-Tween-BSA. The samples and

standards are incubated for approximately 1 hour at room temperature. Next, the bound antibody is treated with a labeled antibody (*e.g.*, horseradish peroxidase conjugated goat-anti-human IgG) for approximately 1 hour at room temperature. Binding of the labeled antibody is detected, *e.g.*, by a spectrophotometer.

The concentration of antibody or antibody fragment levels in the serum of volunteers are corrected by subtracting the predose serum level (background level) from the serum levels at each collection interval after administration of the dose. For each volunteer the pharmacokinetic parameters are computed according to the model-independent approach (Gibaldi et al., eds., 1982, *Pharmacokinetics*, 2nd edition, Marcel Dekker, New York) from the corrected serum antibody or antibody fragment concentrations.

Equivalents

Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific embodiments of the invention described herein. Such equivalents are intended to be encompassed by the following claims.

All publications, patents and patent applications mentioned in this specification are herein incorporated by reference into the specification to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference.

What is claimed is:

1. A method of preventing a respiratory syncytial virus (RSV) infection in a mammal, said method comprising administering to said mammal a dose of a prophylactically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, wherein said prophylactically effective amount is less than 15 mg/kg of said antibodies or antibody fragments.

2. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a mammal infected with RSV, said method comprising administering to said mammal a dose of a therapeutically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, wherein said therapeutically effective amount is less than 15 mg/kg of said antibodies or antibody fragments.

3. The method of claim 1, wherein said antibodies or antibody fragments have an affinity of at least 2 X 10^8 M^{-1} for RSV antigens.

4. The method of claim 2, wherein said antibodies or antibody fragments have an affinity of at least 2 X 10^8 M^{-1} for RSV antigens.

5. The method of claim 1, 2, 3, or 4, wherein the dose is less than 5 mg/kg or less.

6. The method of claim 1, 2, 3, or 4, wherein the dose is 3 mg/kg or less.

7. The method of claim 1, 2, 3, or 4, wherein the dose is 1.5 mg/kg or less.

8. The method of claim 1 or 2, wherein said antibodies or antibody fragments are administered by a nebulizer or inhaler.

9. The method of claim 1 or 2, wherein said antibodies or antibody fragments are administered intramuscularly, intravaneously or subcutaneously.

10. The method of claim 1 or 2, wherein said antibodies or antibody fragments administered 1, 2, 3, 4 or 5 times during the RSV season.

11. The method of claim 7, wherein said antibodies or antibody fragments administered 5 times during the RSV season.

12. The method of claim 6, wherein said antibodies or antibody fragments administered 3 times during the RSV season.

13. The method of claim 5, wherein said antibodies or antibody fragments are administered 2 times during the RSV season.

14. The method of claim 1 or 2, wherein at least one of the antibodies is a human or humanized monoclonal antibody.

15. The method of claim 1 or 2, wherein the mammal is a human subject, a human subject which has had a bone marrow transplant, an elderly human subject, or a human subject which has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

16. The method of claim 1 or 2, wherein the mammal is a human infant.

17. The method of claim 1, wherein the mammal is a human infant born prematurely or is at risk of hospitalization for a RSV infection.

18. The method of claim 1 or 2, wherein at least one of the antibodies has the amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

19. A method of preventing RSV infection in a mammal, comprising administering to said mammal a first dose of a prophylactically effective amount of one or more antibodies that immunospecifically bind to one or more RSV antigens, wherein said prophylactically effective amount is a dose of less than 15 mg/kg of said antibodies or antibody fragments, wherein said administration results in a prophylactially effective serum titer of said antibodies or antibody fragments that is less than 30 μg/ml at least 20 days after the administration of said first dose and prior to the administration of a subsequent dose.

20. A method of treating or ameliorating one or more symptoms associated with RSV infection in a mammal with a RSV infection, comprising administering to said mammal a first dose of a therapeutically effective amount of one or more antibodies that immunospecifically bind to one or more RSV antigens, wherein said therapeutically effective amount is a dose of less than 15 mg/kg of said antibodies or antibody fragments, wherein said administration results in a therapeutically effective serum titer of said antibodies or antibody fragments that is less than 30 μg/ml at least 20 days after the administration of said first dose and prior to the administration of a subsequent dose.

21. The method of claim 19, wherein said antibodies or antibody fragments bind to a RSV antigen with an affinity constant of at least 2 X 10^8 M^{-1}.

22. The method of claim 20, wherein said antibodies or antibody fragments bind to a RSV antigen with an affinity constant of at least 2 X 10^8 M^{-1}.

23. The method of claim 19, 20, 21 or 22, wherein the dose is less than 5 mg/kg or less.

24. The method of claim 19, 20, 21 or 22, wherein the dose is 3 mg/kg or less.

25. The method of claim 19, 20, 21 or 22, wherein the dose is 1.5 mg/kg or less.

26. The method of claim 23, wherein the serum titer is at least 2 μg/ml.

27. The method of claim 24, wherein the serum titer is at least 2 μg/ml.

28. The method of claim 25, wherein the serum titer is at least 2 μg/ml.

29. The method of claim 19, wherein said prophylactically effective serum titer is less than 30 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

30. The method of claim 20, wherein said therapeutically effective serum titer is less than 30 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

31. The method of claim 21, wherein said prophylactically effective serum titer is less than 30 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

32. The method of claim 22, wherein said therapeutically effective serum titer is less than 30 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

33. The method of claim 19, wherein the dose is 1.5 mg/kg or less and said prophylactically effective serum titer is at least 2 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

34. The method of claim 20, wherein the dose is 1.5 mg/kg or less and said therapeutically effective serum titer is at least 2 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

35. The method of claim 21, wherein the dose is 1.5 mg/kg or less and said prophylactically effective serum titer is at least 2 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

36. The method of claim 22, wherein the dose is 1.5 mg/kg or less and said therapeutically effective serum titer is at least 2 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

37. The method of claim 19 or 20, wherein said antibodies or antibody fragments are administered by a nebulizer or inhaler.

38. The method of claim 19 or 20, wherein said antibodies or antibody fragments are administered intramuscularly, intravaneously or subcutaneously.

39. The method of claim 19 or 20, wherein said antibodies or antibody fragments have half-lives in said human subject of greater than 25 days.

40. The method of claim 19 or 20, wherein at least one of the antibodies is a human or humanized monoclonal antibody.

41. The method of claim 19 or 20, wherein the mammal is a human subject, a human subject which has had a bone marrow transplant, an elderly human subject, or a human subject which has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

42. The method of claim 19 or 20, wherein the mammal is a human infant.

43. The method of claim 19, wherein the mammal is a human infant born prematurely or is at risk of hospitalization for a RSV infection.

44. The method of claim 19 or 20, wherein at least one of the antibodies has the amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

45. A method of preventing a RSV infection in a mammal, said method comprising administering to said mammal a first dose of a prophylactically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, wherein said prophylactically effective amount is approximately 15 mg/kg or less of said antibodies or antibody fragments and a prophylactically effective serum titer is maintained for at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

46. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a mammal, said method comprising administering to said mammal a first dose of a therapeutically effective dose of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, wherein said therapeutically effective dose is approximately 15 mg/kg or less of said antibodies or antibody fragments and a therapeutically effective serum titer is maintained for at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

47. The method of claim 45, wherein the antibodies or antibody fragments have an affinity of at least 2×10^8 M^{1-} for said RSV antigens.

48. The method of claim 46, wherein the antibodies or antibody fragments have an affinity of at least 2×10^8 M^{1-} for said RSV antigens.

49. The method of claim 45 or 47, wherein said prophylactically effective serum titer is at least 30 μg/ml of said antibodies or antibody fragments.

50. The method of claim 49, wherein said prophylactically effective serum titer is at least 2 μg/ml of said antibodies or antibody fragments.

51. The method of claim 46 or 48, wherein said therapeutically effective serum titer is at least 30 μg/ml of said antibodies or antibody fragments.

52. The method of claim 51, wherein said therapeutically effective serum titer is at least 2 μg/ml of said antibodies or antibody fragments.

53. The method of claim 45 or 47, wherein the prophylactically effective serum titer is maintained for at least 25 days.

54. The method of claim 45 or 47, wherein the prophylactically effective serum titer is maintained for at least 30 days.

55. The method of claim 46 or 48, wherein the therapeutically effective serum titer is maintained for at least 25 days.

56. The method of claim 46 or 48, wherein the therapeutically effective serum titer is maintained for at least 30 days.

57. The method of claim 49, wherein the prophylactically effective serum titer is maintained for at least 25 days.

58. The method of claim 50, wherein the prophylactically effective serum titer is maintained for at least 25 days.

59. The method of claim 49, wherein the prophylactically effective serum titer is maintained for at least 30 days.

60. The method of claim 50, wherein the prophylactically effective serum titer is maintained for at least 30 days.

61. The method of claim 51, wherein the therapeutically effective serum titer is maintained for at least 25 days.

62. The method of claim 52, wherein the therapeutically effective serum titer is maintained for at least 25 days.

63. The method of claim 51, wherein the therapeutically effective serum titer is maintained for at least 30 days.

64. The method of claim 52, wherein the therapeutically effective serum titer is maintained for at least 30 days.

65. The method of claim 45 or 46, wherein said antibodies or antibody fragments are administered by a nebulizer or inhaler.

66. The method of claim 45 or 46, wherein said antibodies or antibody fragments are administered intramuscularly, intravaneously or subcutaneously.

67. The method of claim 45 or 46, wherein said antibodies or antibody fragments have half-lives in said human subject of greater than 25 days.

68. The method of claim 45 or 46, wherein at least one of the antibodies is a human or humanized monoclonal antibody.

69. The method of claim 45 or 46, wherein the mammal is a human subject, a human subject which has had a bone marrow transplant, an elderly human subject, or a human subject which has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

70. The method of claim 45 or 46, wherein the mammal is a human infant.

71. The method of claim 45, wherein the mammal is a human infant born prematurely or is at risk of hospitalization for a RSV infection.

72. The method of claim 45 or 46, wherein at least one of the antibodies has an amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ

ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

73. A sustained release formulation comprising one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens.

74. A pharmaceutical composition comprising one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens for pulmonary delivery.

75. The sustained release formulation of claim 73, wherein the antibodies or antibody fragments have an affinity of at least 2 X 10^8 M^{1-} for said RSV antigens.

76. The pharmaceutical composition of claim 74, wherein the antibodies or antibody fragments have an affinity of at least 2 X 10^8 M^{1-} for said RSV antigens.

77. The sustained release formulation of claim 73, wherein at least one of the antibodies or antibody fragments is SYNAGIS® or an antigen-binding fragment thereof.

78. The pharmaceutical composition of claim 74, wherein at least one of the antibodies or antibody fragments is SYNAGIS® or an antigen-binding fragment thereof.

79. The sustained release formulation of claim 73, wherein at least one of said antibodies or antibody fragments is a human or humanized antibody or antibody fragment.

80. The pharmaceutical composition of claim 74, wherein at least one of said antibodies or antibody fragments is a human or humanized antibody or antibody fragment.

81. The sustained release formulation of claim 73, wherein at least one of said antibodies at least one of the antibodies has an amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

82. The pharmaceutical composition of claim 74, wherein at least one of said antibodies at least one of the antibodies has an amino acid sequence of SEQ ID NO:7, SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

83. The sustained release formulation of claim 73, wherein at least one of said antibodies or antibody fragments has an increased *in vivo* half-life.

84. The pharmaceutical composition of claim 74, wherein at least one of said antibodies or antibody fragments has an increased *in vivo* half-life.

85. A method of preventing a RSV infection in a mammal, said method comprising administering to said mammal a prophylactically effective amount of the sustained release formulation of claim 73, 75, 77, 79, 81, or 83.

86. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a mammal with a RSV infection, said method comprising administering to said mammal a therapeutically effective amount of the sustained release formulation of claim 73, 75, 77, 79, 81, or 83.

87. A method of preventing a RSV infection in a mammal, said method comprising administering to the lungs of said mammal a prophylactically effective amount of the pharmaceutical composition of claim 74, 76, 78, 80, 82, or 84.

88. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a mammal with a RSV infection, said method comprising administering to the lungs of said mammal a therapeutically effective amount of the pharmaceutical composition of claim 74, 76, 78, 80, 82, or 84.

89. The method of claim 85, wherein the sustained release formulation is administered intramuscularly, intravaneously or subcutaneously.

90. The method of claim 85, wherein the sustained release formulation is administered by a nebulizer or inhaler.

91. The method of claim 86, wherein the sustained release formulation is administered intramuscularly, intravaneously or subcutaneously.

92. The method of claim 86, wherein the sustained release formulation is administered by a nebulizer or inhaler.

93. The method of claim 87, wherein the pharmaceutical composition is administered by a nebulizer or inhaler.

94. The method of claim 88, wherein the pharmaceutical composition is administered by a nebulizer or inhaler.

95. The method of claim 85, wherein the mammal is a human subject.

96. The method of claim 86, wherein the mammal is a human subject.

97. The method of claim 87, wherein the mammal is a human subject.

98. The method of claim 88, wherein the mammal is a human subject.

99. The method of claim 95, wherein the human subject has had a bone marrow transplant, is elderly, or has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

100. The method of claim 96, wherein the human subject has had a bone marrow transplant, is elderly, or has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

101. The method of claim 97, wherein the human subject has had a bone marrow transplant, is elderly, or has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

102. The method of claim 98, wherein the human subject has had a bone marrow transplant, is elderly, or has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

103. The method of claim 95, wherein the human subject is an infant.

104. The method of claim 95, wherein the human subject is an infant born prematurely or is at risk of hospitalization for a RSV infection.

105. The method of claim 96, wherein the human subject is an infant.

106. The method of claim 96, wherein the human subject is an infant born prematurely.

107. The method of claim 97, wherein the human subject is an infant.

108. The method of claim 97, wherein the human subject is an infant born prematurely.

109. The method of claim 98, wherein the human subject is an infant.

110. The method of claim 98, wherein the human subject is an infant born prematurely.

111. A method of preventing a RSV infection in a mammal, said method comprising administering to said mammal a first dose of a prophylactically effective dose of SYNAGIS® or an antigen-binding fragment thereof in a sustained release formulation, wherein said prophylactically effective dose is approximately 15 mg/kg or less of SYNAGIS® or an antigen-binding fragment thereof and a prophylactically effective serum titer of at least 30 μg/ml is maintained for at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

112. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a mammal with a RSV infection, said method comprising administering to said mammal a first dose of a therapeutically effective dose of SYNAGIS® or an antigen-binding fragment thereof in a sustained release formulation, wherein said therapeutically effective dose is approximately 15 mg/kg or less of SYNAGIS® or an antigen-binding fragment thereof and a prophylactically effective serum titer of at least 30 μg/ml is maintained for at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

113. The method of claim 111, wherein said prophylactically effective serum titer is maintained for at least 25 days after the administration of the first dose and prior to the administration of a subsequent dose.

114. The method of claim 111, wherein said prophylactically effective serum titer is maintained for at least 30 days after the administration of the first dose and prior to the administration of a subsequent dose.

115. The method of claim 112, wherein said therapeutically effective serum titer is maintained for at least 25 days after the administration of the first dose and prior to the administration of a subsequent dose.

116. The method of claim 112, wherein said therapeutically effective serum titer is maintained for at least 30 days after the administration of the first dose and prior to the administration of a subsequent dose.

117. The method of claim 111 or 112, wherein SYNAGIS® or an antigen-binding fragment thereof is administered by a nebulizer or inhaler.

118. The method of claim 111 or 112, wherein SYNAGIS® or an antigen-binding fragment thereof is administered intramuscularly, intravaneously or subcutaneously.

119. The method of claim 111 or 112, wherein SYNAGIS® or an antigen-binding fragment thereof is administered 1, 2, 3, 4, or 5 times during the RSV season.

120. The method of claim 111 or 112, wherein the mammal is a human subject, a human subject which has had a bone marrow transplant, an elderly human subject, or a human subject which has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

121. The method of claim 111 or 112, wherein the mammal is a human infant.

122. The method of claim 111, wherein the mammal is a human infant born prematurely or is at risk of hospitalization for a RSV infection.

123. A method of preventing a RSV infection in a mammal, said method comprising administering to said mammal a first dose of a prophylactically effective dose of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with an affinity of at least 2 X 10^8 M^{1-} in a sustained release formulation, wherein said prophylactically effective dose is approximately 15 mg/kg or less of said antibodies or antibody

fragments and a prophylactically effective serum titer of less than 30 μg/ml is maintained for at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

124. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a mammal with a RSV infection, said method comprising administering to said mammal a first dose of a therapeutically effective dose of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens with an affinity of at least 2×10^8 M^{1-} in a sustained release formulation, wherein said therapeutically effective dose is approximately 15 mg/kg or less of said antibodies or antibody fragments and a therapeutically effective serum titer of less than 30 μg/ml is maintained for at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

125. The method of claim 123, wherein said prophylactically effective serum titer is at least 2 μg/ml.

126. The method of claim 123 or 125, wherein said prophylactically effective serum titer is maintained for at least 25 days after the administration of the first dose and prior to the administration of a subsequent dose.

127. The method of claim 123 or 125, wherein said prophylactically effective serum titer is maintained for at least 30 days after the administration of the first dose and prior to the administration of a subsequent dose.

128. The method of claim 124, wherein said therapeutically effective serum titer is at least 2 μg/ml.

129. The method of claim 124 or 128, wherein said therapeutically effective serum titer is maintained for at least 25 days after the administration of the first dose and prior to the administration of a subsequent dose.

130. The method of claim 124 or 128, wherein said therapeutically effective serum titer is maintained for at least 30 days after the administration of the first dose and prior to the administration of a subsequent dose.

131. The method of claim 123 or 124, wherein said antibodies or antibody fragments are administered by a nebulizer or inhaler.

132. The method of claim 123 or 124, wherein said antibodies or antibody fragments are administered intramuscularly, intravaneously or subcutaneously.

133. The method of claim 123 or 124, wherein said antibodies or antibody fragments are administered 1, 2, 3, 4, or 5 times during the RSV season.

134. The method of claim 123 or 124, wherein said antibodies or antibody fragments have half-lives in said human subject of greater than 25 days.

135. The method of claim 123 or 124, wherein at least one of the antibodies is a human or humanized monoclonal antibody.

136. The method of claim 123 or 124, wherein the mammal is a human subject, a human subject which has had a bone marrow transplant, an elderly human subject, or a human subject which has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

137. The method of claim 123 or 124, wherein the mammal is a human infant.

138. The method of claim 123, wherein the mammal is a human infant born prematurely or is at risk of hospitalization for a RSV infection. .

139. The method of claim 123 or 124, wherein at least one of the antibodies has an amino acid sequence of SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

140. A method of preventing a RSV infection in a mammal, said method comprising administering to said mammal a dose of a prophylactically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens and have increased *in vivo* half-lives, wherein said prophylactically effective amount is a dose approximately 15 mg/kg or less of said antibodies or antibody fragments.

141. A method of treating or ameliorating one or more symptoms associated with a respiratory syncytial virus (RSV) infection in a mammal infected with RSV, said method comprising administering to said mammal a dose of a prophylactically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens and have increased *in vivo* half-lives, wherein said prophylactically effective amount is a dose approximately 15 mg/kg or less of said antibodies or antibody fragments.

142. The method of claim 140, wherein said antibodies or antibody fragments have an affinity of at least 2 X $10^8 M^{-1}$ for RSV antigens.

143. The method of claim 141, wherein said antibodies or antibody fragments have an affinity of at least 2 X $10^8 M^{-1}$ for RSV antigens.

144. The method of claim 140, 141, 142 or 143, wherein the dose is less than 5 mg/kg or less.

145. The method of claim 140, 141, 142 or 143, wherein the dose is 3 mg/kg or less.

146. The method of claim 140, 141, 142 or 143, wherein the dose is 1.5 mg/kg or less.

147. The method of claim 140, 141, 142 or 143, wherein the increase in *in vivo* half-life is from 21 days to at least 25 days.

148. The method of claim 140, 141, 142 or 143, wherein the increase in *in vivo* half-life is from 21 days to at least 30 days.

149. A method of preventing a RSV infection in a mammal, said method comprising administering to said mammal a dose of a prophylactically effective amount of HL-SYNAGIS or an antigen-binding fragment thereof, wherein said prophylactically effective amount is a dose of approximately 15 mg/kg or less of SYNAGIS® or an antigen-binding fragment thereof which results in a prophylactically effective serum titer that is at least 30 µg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

150. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a human subject infected with RSV, said method comprising administering

to said human subject a dose of a therapeutically effective amount of HL-SYNAGIS or an antigen-binding fragment thereof, wherein said therapeutically effective amount is a dose of approximately 15 mg/kg or less of SYNAGIS® or an antigen-binding fragment thereof which results in a therapeutically effective serum titer that is at least 30 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

151. The method of claim 149 or 150, wherein said antibodies or antibody fragments are administered by a nebulizer or inhaler.

152. The method of claim 149 or 150, wherein said antibodies or antibody fragments are administered intramuscularly, intravaneously or subcutaneously.

153. The method of claim 149 or 150, wherein the mammal is a human subject, a human subject which has had a bone marrow transplant, an elderly human subject, or a human subject which has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

154. The method of claim 149 or 150, wherein the mammal is a human infant.

155. The method of claim 149, wherein the mammal is a human infant born prematurely or is at risk of hospitalization for a RSV infection.

156. A method of preventing a RSV infection in a mammal, said method comprising administering to said mammal a dose of a prophylactically effective amount of one or more antibodies or fragments thereof, wherein said antibodies or fragments thereof immunospecifically bind to one or more RSV antigens and have increased *in vivo* half-lives, and wherein said prophylactically effective amount is a dose of approximately 15 mg/kg or less of said antibodies or antibody fragments which results in a prophylactically effective serum titer of less than 30 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

157. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a mammal infected with RSV, said method comprising administering to said mammal a dose of a therapeutically effective amount of one or more antibodies or fragments thereof, wherein said antibodies or fragments thereof immunospecifically bind to one or more RSV antigens and have increased *in vivo* half-lives, and wherein said therapeutically effective

amount is a dose of approximately 15 mg/kg or less of said antibodies or antibody fragments which results in a therapeutically effective serum titer of less than 30 μg/ml at least 30 days after the administration of said first dose and prior to the administration of a subsequent dose.

158. The method of claim 156, wherein said antibodies or antibody fragments have an affinity of at least 2 X 10^8 M^{-1} for RSV antigens.

159. The method of claim 157, wherein said antibodies or antibody fragments have an affinity of at least 2 X 10^8 M^{-1} for RSV antigens.

160. The method of claim 156 or 157, wherein the prophylactically effective serum titer is at least 2 μg/ml.

161. The method of claim 156 or 157, wherein the therapeutically effective serum titer is at least 2 μg/ml.

162. The method of claim 149, wherein the prophylactically effective serum titer is at least 40 μg/ml.

163. The method of claim 149, wherein the prophylactically effective serum titer is at least 50 μg/ml.

164. The method of claim 150, wherein the therapeutically effective serum titer is at least 40 μg/ml.

165. The method of claim 150, wherein the therapeutically effective serum titer is at least 50 μg/ml.

166. The method of claim 149, wherein the prophylactically effective serum titer is at least 30 μg/ml at least 35 days after the administration of said first dose and prior to the administration of a subsequent dose.

167. The method of claim 150, wherein the therapeutically effective serum titer is at least 30 μg/ml at least 35 days after the administration of said first dose and prior to the administration of a subsequent dose.

168. The method of claim 156 or 158, wherein the prophylactically effective serum titer is at least 2 μg/ml at least 35 days after the administration of said first dose and prior to the administration of a subsequent dose.

169. The method of claim 157 or 159, wherein the therapeutically effective serum titer is at least 2 μg/ml at least 35 days after the administration of said first dose and prior to the administration of a subsequent dose.

170. The method of claim 149 or 150, wherein HL-SYNAGIS or an antigen-binding fragment thereof is formulated in a sustained release formulation.

171. The method of claim 156 or 157, wherein said antibodies or fragments thereof are formulated in a sustained release formulation.

172. The method of claim 156 or 157, wherein said antibodies or fragments thereof are administered by a nebulizer or inhaler.

173. The method of claim 156 or 157, wherein said antibodies or fragments thereof are administered intramuscularly, intravaneously or subcutaneously.

174. The method of claim 156 or 157, wherein said antibodies or fragments thereof have half-lives in said human subject of greater than 25 days.

175. The method of claim 156 or 157, wherein at least one of the antibodies is a human or humanized monoclonal antibody.

176. The method of claim 156 or 157, wherein the mammal is a human subject, a human subject which has had a bone marrow transplant, an elderly human subject, or a human subject which has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

177. The method of claim 156 or 157, wherein the mammal is a human infant.

178. The method of claim 156, wherein the mammal is a human infant born prematurely or is at risk of hospitalization for a RSV infection.

179. The method of claim 156 or 157, wherein at least one of said antibodies comprises a VH CDR1 having the amino acid sequence of SEQ ID NO:1, SEQ ID NO:12 or SEQ ID NO:44, a VH CDR2 having the amino acid sequence of SEQ ID NO:2, SEQ ID NO:45, SEQ ID NO:52, SEQ ID NO:66, SEQ ID NO:75 or SEQ ID NO:96, a VH CDR3 having the amino acid sequence of SEQ ID NO:3, SEQ ID NO:13, SEQ ID NO:22, SEQ ID NO:32 or SEQ ID NO:46, a VL CDR1 having the amino acid sequence of SEQ ID NO:4, SEQ ID NO:15, SEQ ID NO:38, SEQ ID NO:48, SEQ ID NO:58 or SEQ ID NO:86, a VL CDR2 having the amino acid sequence of SEQ ID NO:5, SEQ ID NO:16, SEQ ID NO:26, SEQ ID NO:29, SEQ ID NO:36, SEQ ID NO:41, SEQ ID NO:49, SEQ ID NO:54, SEQ ID NO:59, SEQ ID NO:63, SEQ ID NO:72, SEQ ID NO:77, SEQ ID NO:91 or SEQ ID NO:95, or aVL CDR3 having the amino acid sequence of SEQ ID NO:6 or SEQ ID NO:17

180. A method of preventing a RSV infection in a mammal, said method comprising administering to the lungs of said mammal a first dose of a prophylactically effective amount of a composition comprising one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, wherein said prophylactically effective amount results in a prophylactically effective concentration of at least 20 ng per mg of lung protein at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

181. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a mammal infected with RSV, said method comprising administering to the lungs of said mammal a first dose of a therapeutically effective amount of a composition comprising one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, wherein said therapeutically effective amount results in a therapeutically effective concentration of at least 20 ng per mg of lung protein at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

182. The method of claim 180, wherein said antibodies or antibody fragments have an affinity of at least 2 $X10^8 M^{-1}$ for RSV antigens.

183. The method of claim 181, wherein said antibodies or antibody fragments have an affinity of at least 2 $X10^8 M^{-1}$ for RSV antigens.

184. The method of claim 180 or 181, wherein said antibodies or antibody fragments have *in vivo* half-lives of greater than 30 days.

185. The method of claim 180 or 181, wherein said antibodies or antibody fragments have *in vivo* half-lives of greater than 30 days.

186. The method of claim 180 or 181, wherein said antibodies or antibody fragments are administered by a nebulizer or inhaler.

187. The method of claim 180 or 181, wherein said antibodies or antibody fragments are administered intramuscularly, intravaneously or subcutaneously.

188. The method of claim 180 or 181, wherein at least one of said antibodies is a human or humanized monoclonal antibody.

189. The method of claim 180 or 181, wherein the mammal is a human subject, a human subject which has had a bone marrow transplant, an elderly human subject, or a human subject which has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

190. The method of claim 180 or 181, wherein the mammal is a human infant.

191. The method of claim 180 or 181, wherein the mammal is a human infant born prematurely or is at risk of hospitalization for a RSV infection.

192. The method of claim 180 or 181, wherein at least one of the antibodies has an amino acid sequence of SEQ ID NO:10, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:88 or SEQ ID NO:92.

193. A method of preventing a RSV infection in a mammal, said method comprising administering to the lungs of said mammal a first dose of a prophylactically effective amount of a composition comprising SYNAGIS® or a fragment thereof, wherein said prophylactically effective amount results in a prophylactically effective concentration of at least 20 ng per mg of lung protein at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

194. A method of treating or ameliorating one or more symptoms associated with a RSV infection in a mammal infected with RSV, said method comprising administering to the

lungs of said mammal a first dose of a therapeutically effective amount of a composition comprising SYNAGIS® or a fragment thereof, wherein said therapeutically effective amount results in a therapeutically effective concentration of at least 20 ng per mg of lung protein at least 20 days after the administration said first dose and prior to the administration of a subsequent dose.

195. The method of claim 193 or 194, wherein SYNAGIS® or an antigen-binding fragment thereof is administered by a nebulizer or inhaler.

196. The method of claim 193 or 194, wherein SYNAGIS® or an antigen-binding fragment thereof is administered intramuscularly, intravaneously or subcutaneously.

197. The method of claim 193 or 194, wherein the mammal is a human subject, a human subject which has had a bone marrow transplant, an elderly human subject, or a human subject which has cystic fibrosis, bronchopulmonary dysplasia, congenital heart disease, congenital immunodeficiency or acquired immunodeficiency.

198. The method of claim 193 or 194, wherein the mammal is a human infant..

199. The method of claim 193, wherein the mammal is a human infant born prematurely or is at risk of hospitalization for a RSV infection.

ABSTRACT

The present invention encompasses novel antibodies and fragments thereof which immunospecifically bind to one or more RSV antigens and compositions comprising said antibodies and antibody fragments. The present invention encompasses methods preventing respiratory syncytial virus (RSV) infection in a human, comprising administering to said human a prophylactically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, wherein a certain serum titer of said antibodies or antibody fragments is achieved in said human subject. The present invention also encompasses methods for treating or ameliorating symptoms associated with a RSV infection in a human, comprising administering to said human a therapeutically effective amount of one or more antibodies or fragments thereof that immunospecifically bind to one or more RSV antigens, wherein a certain serum titer of said antibodies or antibody fragments is achieved in said human subject. The present invention further encompasses compositions comprising antibodies or fragments thereof that immunospecifically bind to a RSV antigen, and methods using said compositions for detection or diagnosis a RSV infection

A

DIQMTQSPST LSASVGDRVT ITCKCQLSVGYMH WYQQKPG 40
CDR L1

KAPKLLIY DTSKLAS GVPSR FSGSGSGTEF TLTISSLQPD 80
CDR L2

DFATYYC FQGSGYPFT FGGGTKLEIK 106
CDR L3

B

QVTLRESGPA LVKPTQTLTL TCTFSGFSLS TSGMSVG WIR 40
CDR H1

QPPGKALEWL A DIWWDDKKDYNPSLKS RLT ISKDTSKNQV 80
CDR H2

VLKVTNMDPA DTATYYCAR SMITNWYFDV W GAGTTVTVSS 120
CDR H3

FIG. 1

A

DIQMTQSPST LSASVGDRVT ITC<u>SASSSVGYMH</u> WYQQKPG 40
CDR L1

KAPKLLIY <u>DTSKLAS</u> GVPSR FSGSGSGTEF TLTISSLQPD 80
CDR L2

DFATYYC <u>FQGSGYPFT</u> FGGG TKVEIK 106
CDR L3

B

QVTLRESGPA LVKPTQTLTL TCTFSGFSLS <u>TSGMSVG</u> WIR 40
CDR H1

QPPGKALEWL A <u>DIWWDDKKDYNPSLKS</u> RLT ISKDTSKNQV 80
CDR H2

VLKVTNMDPA DTATYYCAR <u>SMITNWYFDV</u> WGQGTTVTVSS 120
CDR H3

FIG. 2

DECLARATION FOR NON-PROVISIONAL PATENT APPLICATION*

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below at 201 et seq. beneath my name.

I believe I am the original, first and sole inventor if only one name is listed at 201 below, or an original, first and joint inventor if plural names are listed at 201 et seq. below, of the subject matter which is claimed and for which a patent is sought on the invention entitled

METHODS OF ADMINISTERING/DOSING ANTI-RSV ANTIBODIES FOR PROPHYLAXIS AND TREATMENT

and for which a patent application:
□ is attached hereto and includes amendment(s) filed on *(if applicable)*
□ was filed in the United States on as Application No. *(for declaration not accompanying application)*
with amendment(s) filed on *(if applicable)*
□ was filed as PCT international Application No. on and was amended under PCT Article 19 on *(if applicable)*

I hereby state that I have reviewed and understand the contents of the above identified application, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

EARLIEST FOREIGN APPLICATION(S), IF ANY, FILED PRIOR TO THE FILING DATE OF THE APPLICATION			
APPLICATION NUMBER	COUNTRY	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			YES □ NO □
			YES □ NO □
			YES □ NO □

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

PROVISIONAL APPLICATION NUMBER	FILING DATE

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information known to me which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

NON-PROVISIONAL APPLICATION SERIAL NO.	FILING DATE	STATUS		
		PATENTED	PENDING	ABANDONED

* for use only when the application is assigned to a company, partnership or other organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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